Instruments

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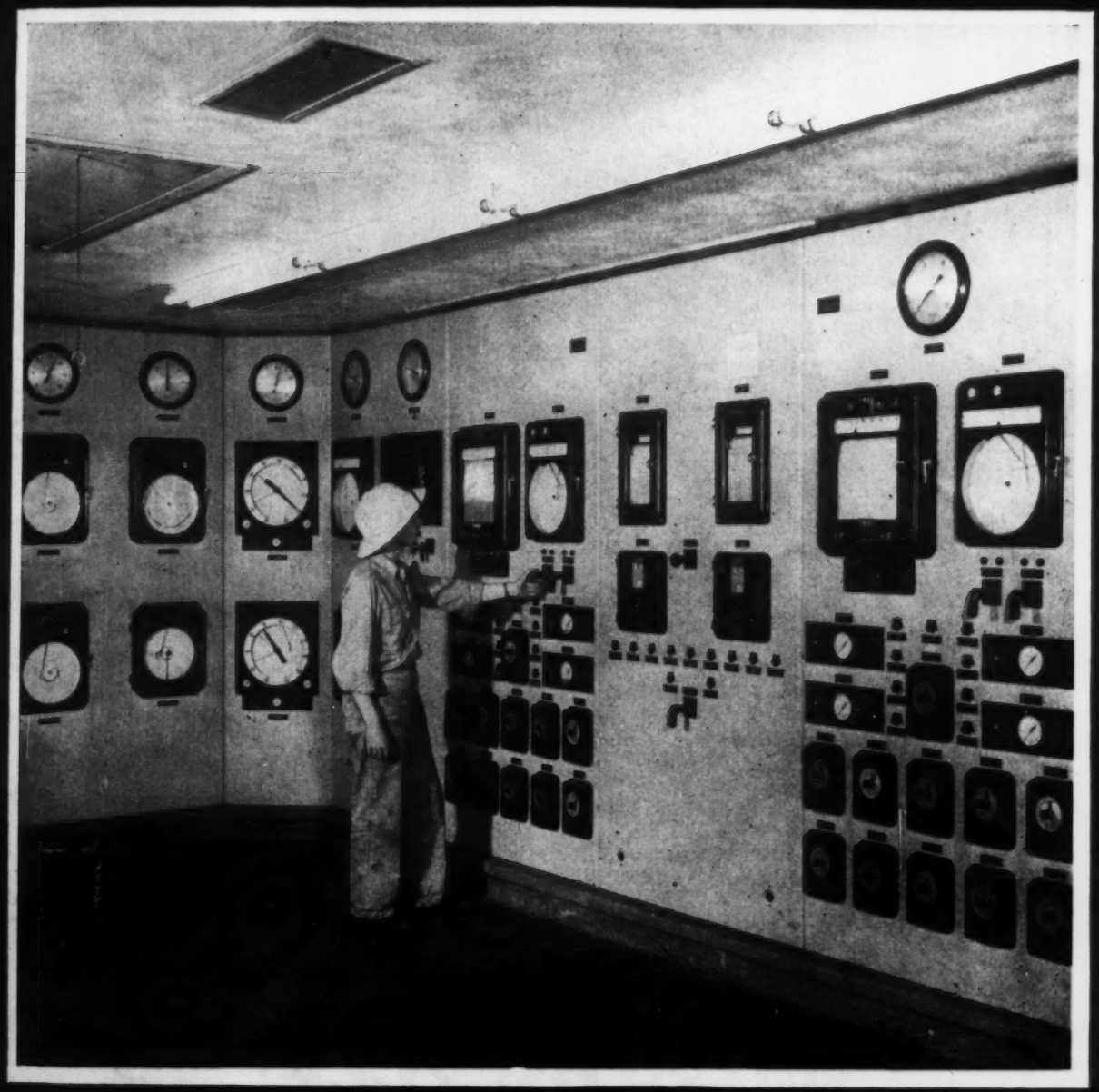

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Instruments THE MAGAZINE OF Measurement and Control

M. F. BEHAR, Editor

Instrumentation's Cost-cutting Functions Benefit Capital, Labor *and* Consumers

IT seems safe to assert that *Instruments* has not only readers but disciples — enthusiastic disciples — in the Harvard Graduate School of Business Administration. We haven't asked the young ladies in the Circulation Department to verify our assertion by reporting how many *Instruments* subscribers in and near Cambridge, Mass., can be spotted as HGSBA faculty members or graduate students. And we don't intend to have subscribers' cards examined, for we are certain that our assertion is true — though it is based on a deduction.

Why is the deduction a certainty?

Because groups of HGSBA students, in term papers on the theme "1959," predict that the next ten years will witness greater use of automatic control of industrial processes. Because some of them predict that, by 1959, automatic control will, in some cases, reduce labor costs by eighty percent.

These predictions are reported in the latest Industrial Bulletin of Arthur D. Little, Inc., the well-known Cambridge firm of chemists and engineers.* An extended quotation is appropriate:

"Peering into the future is always fascinating . . . Now it is also part of the course in manufacturing conducted at the Harvard Graduate School of Business Administration by Georges Doriot. This colorful industrial engineer's Gallic creativeness . . . general problems of management, including, especially, provision for the future of business. Particular emphasis is placed on technological change influencing business development . . .

"For the term paper, groups of three to six students report on an industry as it might look ten years hence. . . . The reports . . . seem to be characterized by a general optimism . . . few of the reports predict a serious depression, although some see a relatively minor one for the early 1950's. War is not generally expected.

". . . Although automatic industrial controls have not yet created the automatic factory by 1959, [one term paper] reports them well on the way. After a depression ending in 1953, the metal-working industries find profit margins so reduced by fixed labor costs that they adopt automatic controls for machine tools, reducing labor costs by 80 percent. As industry emerges from this depression, it increases production by more automatic controls, rather than by rehiring workers.

". . . The automatic merchandising industry does as much as anything to revolutionize life by 1959. Sales in coin machines are up to $20 billion from the $3.5 billion of 1949. With such new features as an automatic bill changer, coin machines sell magazines, men's shirts, diapers, and movie tickets. The ticket vendor is coupled with an electric eye, which counts outgoing patrons, keeping ticket sales in line with the capacity of the theatre. The Keedoozle, or automatic grocery store, is a great success and a serious competitive threat to chain stores which do not adopt the system."

No predictions are reported as to the broad SOCIAL EFFECTS of cutting production costs. We wonder whether any HGSBA students use the old propaganda expression "technological unemployment" that was current in the depression of 1929-1933. If the group who laid stress on automatic process control studied more than the recent issues of *Instruments* in the course of their literature research — if they studied the preachments of this page throughout the last two decades — they discovered that we fought the "technological unemployment" alarmists by coining the CORRECT expression "TECHNOLOGICAL DISPLACEMENT WITH UPGRADING" —which sums up the blessings of Instrumentation.

As a matter of fact, it is exactly twenty-five years since the first formulation of the reasons why Industry should be instrumentized. We listed only eight reasons in 1924, but most of them were too broad and, for the sake of exactitude, we split up and specified, and for about twelve years the list of functions assigned to measurement-and-control instruments has been worded with few changes. Here it is again, exactly as printed a year ago:

1. Minimizing the sum total of human drudgery, especially in eliminating repetitive operations and particularly in automatic dimensional gaging, automatic inspection of products, automatic grading, etc.;
2. Creating new and better kinds of jobs;
3. Bettering working conditions;
4. Labor saving in the sense of increasing productivity bringing about higher wages and lower prices;
5. Fuel saving and electric-energy saving in utilization;
6. Materials saving;
7. Prolonging the service-life of processing equipment;
8. Increasing production from processing equipment;
9. Accelerated modification of processing equipment, even to scrapping present equipment in acceptance of the oft-repeated preachment "Design controllability into production units!";
10. Better quality and uniformity of product;
11. Minimization (sometimes elimination) of rejects;
12. Minimizing reliance on human watchfulness;
13. Accident prevention;
14. Accelerating the conversion of batch processes to continuous processes;
15. Closer control in both senses: (a) product control and (b) automatic control;
16. Improvements in services rendered to the public by ALL of the competing transportation industries;
17. Ditto for the communications industries;
18. Continued improvements in meteorology, navigation, geophysical sciences, biological sciences, preventive and curative medical practices . . . and numerous other non-industrial fields depending increasingly on instruments.
19. Creating new industries and rehabilitating and expanding old industries.

Note well that this is the list of FUNCTIONS. The beneficial EFFECTS of Industry's ever-increasing installation of measurement-and-control devices have been explained in detail in about fifty dissertations on this page — enough to make a 150-page book. "Leisure Dividends of Instrumentation," "Leadership," "100% Automatic Inspection," "Advancement," "The Small Plant," "Too Many Bolt-tighteners," and "Automaticity MAKES Jobs" are some of the titles of editorials printed before 1937. Some of them included predictions. All these predictions have come true. If the future-peering HGSBA students study them, they will agree with us that

The Machine Age Was Not Free From Evils
But the Age of Instruments
Is Making Technology a Pure Blessing.

*A firm we've admired since their January 1933 Bulletin was devoted to automatic process control and titled "Industry's Third Horizon?"

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SIMPLIFIED INSTRUMENTATION

By JOHN S. LESLIE, President, Leslie Co., Lyndhurst, New Jersey

MANY features of control principles which are incorporated by various and complex means in air- and hydraulic-operated automatic controllers, or electric and electronic control instruments, are also available in simplified form with certain definite advantages in self-contained regulators of the internal-pilot piston-operated type.

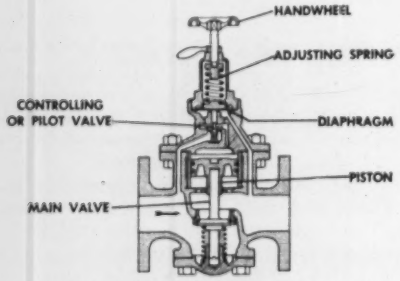


Fig. 1. Pressure-reducing Valve

This fact is appreciated by many instrument and operating engineers but the purpose of this talk is to illustrate some of these features that are particularly advantageous.

Pressure-reducing Valves

As the basic design around which a typical line of self-contained regulators has been built, let us first consider the self-contained internal-pilot piston-operated pressure-reducing valve (Fig. 1) which was first introduced at the turn of the century. When properly designed and built of the best materials, this is one of the most reliable pressure regulators available for long trouble-free service. It provides flexibility to cover wide ranges of reduced pressures and flows.

At this point, it may not be out of order to remark that many of these "simple" self-contained regulators "look" alike on paper but comparing the results is like comparing an electronic tube in a portable radio with one which "looks" just like it but is designed for long reliable service in railway signaling equipment.

The internal pilot or controlling valve is operated by a heavy metal diaphragm which is actuated by the reduced pressure acting upward and the adjusting spring acting downward. This diaphragm also acts as a seal, thereby eliminating the need for a packing gland or stuffing box.

In bronze reducing valves, this diaphragm is made of 0.025-in. thick phosphor bronze and in steel reducing valves of 0.032-in.-thick Monel, each with 2¼-in. effective diameter. As the adjusting spring deflects the diaphragm and opens the controlling or pilot valve, high-pressure steam is admitted through the steam port on the inlet side of the regulator, past the controlling valve to the top of the piston which opens the main valve. The downstream pressure acts through the steam port on the outlet side of the regulator against the underside of the diaphragm to balance the compression set by the handwheel on the adjusting spring. The travel of the controlling or pilot valve is normally

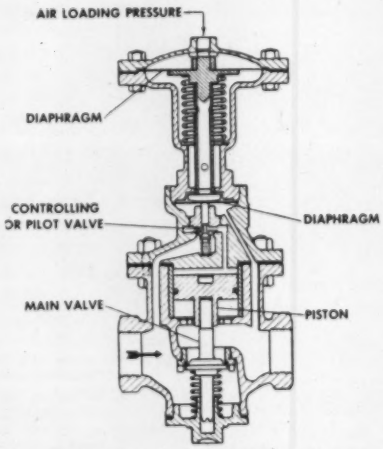


Fig. 2. Remotely-adjusted Reducing Valve

less than 0.020-in., so the deflection of the diaphragm is less than its own thickness. Actually, only 0.015-in. movement of the controlling or pilot valve is necessary to stroke the main valve over its full travel whether half-inch or six-inch size.

In internal-pilot-operated regulators, the internal steam ports just referred to play a very important part in their successful operation. If these ports are not large enough to prevent clogging, they may be troublesome and require frequent cleaning. But, when properly sized and located so as to be self-draining, they will give no trouble.

These facts indicate why these reducing valves are sensitive to small pressure changes and operate with 99 percent accuracy of regulation. They are extremely responsive and will actually operate from fully open to tight shut-off in a fraction of a second with a sudden load change. A load change resulting in a momentary increase or decrease in controlled pressure acts simultaneously on the main valve and pilot valve. Since for any given condition there is a constant pressure on top of the piston, any change in reduced pressure is felt on the under side of the piston, as well as on the under side of the diaphragm, causing the piston to actuate the main valve at the same time that the diaphragm actuates the controlling valve, varying the pressure on the top of the piston. This, therefore, gives a double effect and the controlling or pilot valve becomes only a vernier adjustment.

Even with this sensitivity and quick response, these reducing valves operate with good stability because of ample balancing forces and do not hunt or cycle with slower load variations. Air-operated controllers seldom, if ever, incorporate all these features.

Please note that in this and all other self-contained regulators we will discuss, only single-seated construction is employed regardless of inlet pressure or pressure drop, thereby assuring tight shut-off under no-load conditions and simplified maintenance of valves and seats.

As a self-contained reducing valve this design and these features also make

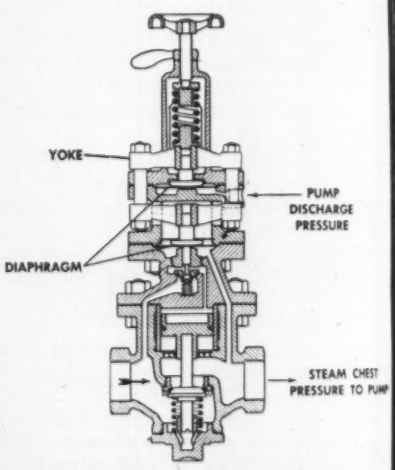


Fig. 3. Pump Governor for Reciprocating Pump

possible a wide range of reduced pressure adjustment in a single valve. In bronze body construction for initial steam pressures from 25 to 300 psi., or to 400-psi. air or gas pressure, one diaphragm and spring can be adjusted by means of the handwheel to give a reduced pressure from 10 psi. to 285 psi. and another spring and diaphragm from 2 psi. to 35 psi. In steel body construction for initial steam pressures up to 600 psi., 750 F., or to 1000 psi. air or gas pressure, one diaphragm and spring has a range of 25 to 400 psi. and another from 10 to 50 psi.

In high-pressure steam service, up to 1500 psi., 1000 F., or 3400 psi. air or gas, the adjustable reduced pressure range is 100 to 600 psi. These figures are not theoretical but are based on actual experience in service and all of them have been proved over five to fifty

*Presented before Rochester (N. Y.) Section ISA Jan. 25, 1949; Akron Section ISA, Jan. 25, 1949; Southern Tier Section and Cornell Student Branch ASME, Ithaca, N. Y., Jan. 26, 1949; ASME Seminar, Georgia Inst. of Tech., Atlanta, April 26, 1949; St. Louis Section ISA, May 4, 1949; Cleveland Section ISA, May 25, 1949. Most of the illustrations, however, have since then been re-drawn especially for *Instruments*.

"Simplified Instrumentation indicates that many control problems can be solved by well-engineered self-contained regulators.

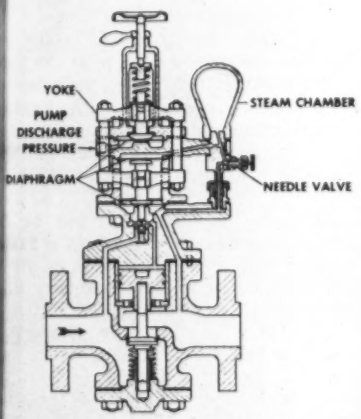
"Where extremely sensitive response is required, the air- or water-operated controller will do a better job than the self-contained regulator.

"But, whatever the problem, it is always wise to be sure that a particular regulator is recommended by the manufacturer for a given service before it is installed or before it is condemned once it has been installed."

ars of actual successful operation in fields — industrial, railroad, and arine.

Where remote adjustment is advangeous, these reducing valves are furhed with a second metal diaphragm lieu of a handwheel (Fig. 2) and an loading panel. The size of the two aphragms gives a one-to-seven ratio air loading pressure to reduced eam pressure, and adjustments can quickly and easily made on the knob the air-loading panel from a control ard, office, or other convenient locaon.

This modification of a standard reucing valve is also furnished for use a diaphragm-motor valve for use ith an air-operated controller where uffing boxes are troublesome or undesirable. Note that the internal pilot lve provides a built-in pressure conol and that full main valve travel is



g. 4. Pump Governor for Turbine-driven Pump

tained with a maximum diaphragm avel of 0.020 in. requiring minimum r displacement per increment of pre- re change from the controller. A ressure-limiting adjusting spring on e lower diaphragm is also available hich can be set to limit the down- eam pressure to any desired maxium regardless of air pressure applied the top diaphragm.

The internal-pilot piston-operated recing valve for steam, air or gas repnts "simplified instrumentation" as compared to an air-operated controller for the following reasons:

1. It is less expensive and more compact to install.
2. It uses no air and requires no maintenance of stuffing boxes.
3. It gives comparable accuracy of regulation and will respond to sudden load changes faster.

Control of Steam Pumps

The next adaptation of the principle of self-contained internal-pilot piston-operated regulator came in 1927 with the introduction of a pump governor (Fig. 3) which incorporates all the features of the reducing valve just described, with more accurate, dependable control of reciprocating pumps than is possible with any other self-contained governor.

This design is suitable for pump discharge pressures from 25 psi. to 200 psi. and you will note that the adjusting spring is balanced by the sum of the pump-discharge pressure acting upward on the upper diaphragm and the steam-chest pressure acting in the same direction on the lower diaphragm. These two diaphragms are connected by a mechanical yoke.

For pump discharge pressures above 200 psi., an additional steam diaphragm is added (Fig. 4) between these two diaphragms to balance out the effect of the steam-chest pressure so that the adjusting spring is balanced only by the pump-discharge pressure. In this design, one spring has an adjustable range of 100 to 350 psi. and another from 300 to 1000 psi.

For control of turbine-driven pumps, the designs just described would be too fast and would result in hunting or cycling. So an automatic reset mechanism has been incorporated in the governor in Fig. 4 which permits sensitive control and good stability. This is accomplished by use of a needle valve and steam chamber between the two steam diaphragms which give an automatic-reset action as follows:

A load increase on the pump is reflected by a momentary drop in pump discharge pressure acting under the top diaphragm, thereby permitting the adjusting spring to force the yoke down, further opening the controlling or pilot valve to raise the piston pressure and open the main valve, thus increasing the steam pressure to the turbine.

The increase in steam pressure on the outlet side of the regulator acts through the outlet steam port upward on the lower steam diaphragm, balancing the drop in pump discharge pressure and thus preventing excessive opening of the main valve which would otherwise cause over-regulating and hunting. The balancing effect of this outlet steam pressure acting in a downward direction on the middle steam diaphragm is delayed by the throttling action of the needle valve and the volume of the steam chamber. From this it can be seen that the initial change in outlet steam pressure from the governor and to the turbine is directly proportional to the amount of change in pump discharge pressure. The needle valve can be adjusted so that the time of this delayed balancing will correspond to the lag caused by the inertia of the impellers in the turbine and pump.

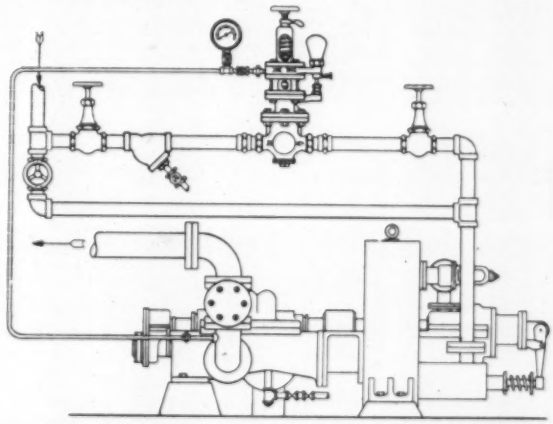


Fig. 5. Installation of Pump Governor in Boiler Feed Service

This reset action is equally effective when the load change is in the opposite direction. That is, a decreasing load causes a momentary increase in pump discharge pressure acting on the top diaphragm which causes the controlling or pilot valve to throttle and reduce the steam pressure to the turbine and on the underside of the lower steam diaphragm. However, the steam pressure which is trapped in the steam chamber continues to act downward on the middle steam diaphragm to compensate for the drop in pump discharge pressure and thus prevents the governor from closing too much or too quickly. This pressure on the top of the middle steam diaphragm gradually drops as it equalizes through the needle valve with the upward pressure on the lower steam diaphragm by the time the turbine has slowed down sufficiently to maintain the set discharge pressure.

Fig. 5 shows this type of pump governor installed on a typical turbine-driven boiler feed pump. In addition to the thousands of applications of this governor in industrial service, it is standard equipment on ships of the U. S. Merchant Marine and U. S. Navy in steam pressures from 100 psi. to 875 psi. and controlling pump discharge pressures from 8 psi. to 1000 psi. This is a good example of "simplified instru-

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mentation" which gives reliable operation with many features of instrument control, including automatic reset, at a reasonable cost and with many definite advantages, including compactness, single-seated construction, metallic diaphragms and no packing glands on any moving parts.

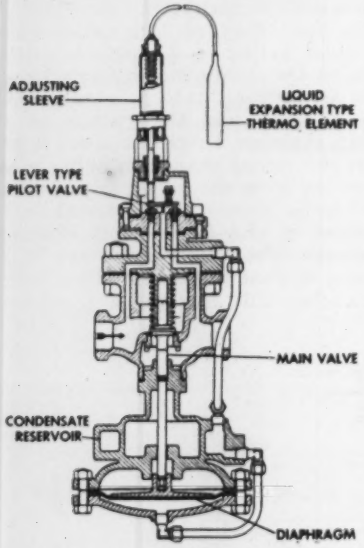

Fig. 6. Temperature Regulator

Temperature Regulators

Self-contained internal-pilot-operated regulators also offer unusual advantages for temperature control. We will consider two types, one responsive only to temperature changes and the other combining pressure and temperature control in a unique design.

The first type (Fig. 6) is designed like a diaphragm-motor valve with an internal lever type pilot actuated by a compact liquid-expansion type thermal element. Pressure admitted by the pilot, through the inlet port and copper tubing to the diaphragm, controls the main valve in a manner similar to an air-operated controller. The amount of opening of this valve is a direct function of temperature change at the bulb.

There is no adjustment for throttling range except in the selection of the thermostatic element which is easily replaceable without shutting down the steam or liquid flow. Standard elements have 50, 100 or 200 F. adjustable temperature range with corresponding throttling ranges of 2, 4 and 8 degrees.

Suitable for steam pressure from 0 to 125 psi. this temperature regulator incorporates single-seated construction in all sizes from ½-in. to 4 in., is tight-closing and will not permit controlled temperatures to creep during periods when no heat is required, such as in washroom water heaters, etc. It can easily be converted from control of steam for heating service to control of water for cooling service by simply turning the superstructure half-way around without change or replacement of any parts. This reverses the effect of the thermal element by changing the action of the lever pilot so that an increase in temperature opens instead of closes the regulator.

For storage type heaters in any service, it is the most dependable, trouble-free low-pressure self-contained temperature regulator available. It is "simplified instrumentation" because it provides accurate control and reliability through the use of a high-powered compact thermostatic element plus a choice of throttling ranges not generally found in self-operated temperature regulators.

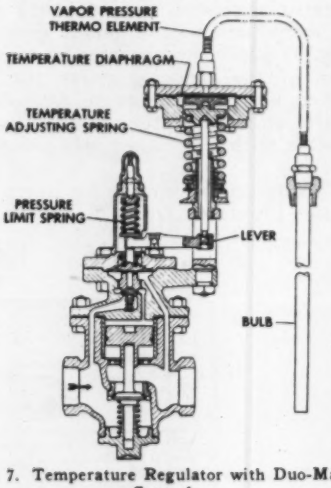

Fig. 7. Temperature Regulator with Duo-Matic Control

"Duo-matic" Control

A self-contained regulator incorporating Duo-matic control (pressure and temperature) and utilizing the internal-pilot piston-operated principle is illustrated by the combination pressure reducing valve and temperature regulator shown in Fig. 7. It is essentially a pressure-reducing valve with the addition of a rugged vapor-pressure thermostatic element which actuates a 0.016-in.-thick phosphor-bronze temperature diaphragm to balance the force of the temperature-adjusting spring and the pressure-limit spring.

With the bulb of the thermal element cold or the temperature-adjusting spring compressed to a point where the rod has no effect on the lever connecting it to the steam diaphragm, the maximum steam pressure desired or permissible in the heater is set on the pressure-limit spring as if it were only a reducing valve. Then the bulb is brought up to the maximum temperature desired and the temperature spring is adjusted so that the regulator just closes at this point.

Then, as the temperature at the bulb begins to drop (owing to an increased load on the heater) the compression on the pressure-limit spring begins to act on the steam diaphragm. For each degree drop in temperature at the bulb, there is an increase of 4 to 4½ psi. steam pressure at the outlet of the regulator. So, actually, the thermostatic element on this regulator resets the pressure-reducing valve and, at any given setting or load on the heater, full capacity of the regulator at that pressure setting is available.

For example, after the regulator has been closed as a result of [illegible] load [illegible] the heater and a flow is start[illegible] through the heater which results in a [illegible]-degree drop in temperature at the b[illegible], an[illegible] let steam pressure from the [illegible]regulat[illegible] of 8 to 9 psi. will result. [illegible]nd, s[illegible] the regulator is now acting [illegible] a rec[illegible] ing valve set to deliver 8 p[illegible], it [illegible] deliver all the steam the [illegible]ater [illegible] condense at this pressure. S[illegible]hould [illegible] temperature drop an additio[illegible]al deg[illegible] the pressure to the heater [illegible]will be [illegible] creased to 12 to 13 psi. T[illegible]his act[illegible] results in good modulation, combin[illegible] with accuracy and stability.

Another feature of this design wh[illegible] contributes to its success is its "anti[illegible] pating" action when a load change [illegible] curs. Do not confuse "anticipating" [illegible]

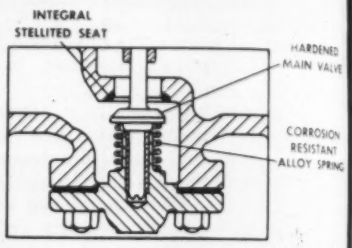

Fig. 8. Main Valve and Stellited Seat

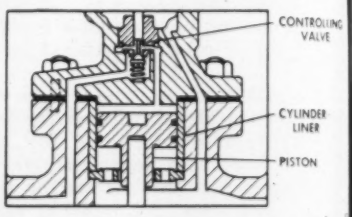

Fig. 9. Cylinder Liner, Piston and Controlling Valve

tion in this regulator with "Pre-act" [illegible] an air-operated controller. "Pre-act" re[illegible] quires a temperature change at the the[illegible] mostatic element before any valve actio[illegible] results. This regulator with "antic[illegible] pating" action will actually respond [illegible] a load change in the heater BEFORE a[illegible] temperature change is felt at the bul[illegible]

This again is due to its action as a r[illegible] ducing valve. A load increase or [illegible] crease in the heater will mean a fast[illegible] or slower rate of condensation of stea[illegible] which will result in a momentary dr[illegible] or increase in pressure at the outlet [illegible] the regulator due to the change [illegible] steam flow required. This pressure v[illegible] iation will be immediately felt on th[illegible] steam diaphragm and cause the pi[illegible] valve to reposition itself to increase [illegible] decrease the main valve opening [illegible] maintain the pressure determined [illegible] the temperature of the bulb at that [illegible] ment.

So, by the time the load change in t[illegible] heater has affected the temperature [illegible] the bulb, the pressure sensitive eleme[illegible] of the regulator has already made [illegible] partial correction and the final corr[illegible] tion to be accomplished by the ther[illegible] element is materially reduced, ther[illegible] resulting in more accurate and sta[illegible] regulation.

Here again is "simplified instrume[illegible] tation" achieved through the combin[illegible]

wo functions in one regulator with urate control, anticipating action, good throttling characteristics. I ght add that this is the most success- control for instantaneous type heat- particularly where sudden load nges occur.

n all self-contained regulators, ma- ials, as well as quality workmanship, y an important part in their success- operation. As a regulator manufac- er with almost fifty years' experi- e, we are keenly aware of the im- rtance of carefully controlled cast- s, accurate machining, rigid inspec- n of each part and full steam testing completed units to assure minimum intenance and maximum satisfac- n in the field. We manufacture our tire line of regulators and controllers our own plant and make all iron and onze castings in our own foundry ich we have operated for 44 years.

Fig. 8 shows the most erosion-resist- t materials available for steam throt-

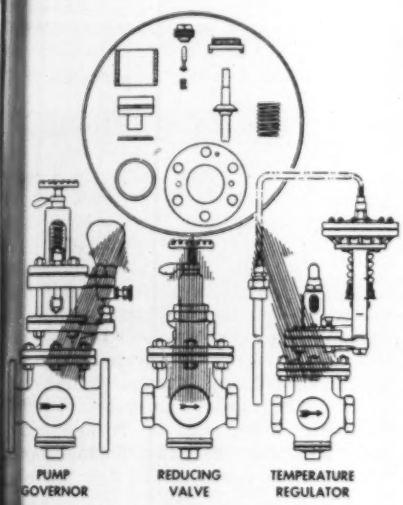

Fig. 10. Self-contained Regulators with Interchangeable Parts

g service. The main valve is stainless el, heat-treated to 500 Brinell with und stems and seat. The seating sur- e is stellite, welded integral to the ting of this steel body. This same terial is welded to a stainless steel t ring in regulators of semi-steel or nze body construction. This combi- ion of materials will assure tight ting for many years under what uld normally be considered very se- e service for conventional valve trim. The cylinder liner and controlling or t valve shown in Fig. 9 are also inless steel, heat-treated to 500 Bri- l, ground finish to provide maximum and minimum friction since the t valve and piston are actually float- on the line at all times.

ig. 10 shows the similarity in ap- rance of a self-contained internal- t piston-operated reducing valve, mp governor and temperature regu- r. Different superstructures using ctly the same controlling valve, con- lling valve seat and controlling valve ing are mounted on a standard reg- ing valve body. In any given size, all of the parts shown are fully interchangeable in all of these regulators and the internal parts in the top cap are the same in all sizes from ½ in. to 6 in. inclusive. This interchangeability feature permits real flexibility in the application of these regulators and minimizes the number of spare parts to be carried. It also makes the training of maintenance men easier, since the understanding of one unit will apply to all.

Remote Shut-down

For remote electrical shut-down, any of these regulators is available with a ¼ in. connection for an external steam supply to the controlling valve in lieu of the internal port as indicated in Fig. 11 and a ¼ in. solenoid valve to operate in conjunction with some other control command such as a float, thermostat, etc. Shutting off this ¼ in. external supply line will then shut down the regulator whether it is ½-in. or 6-inch size. A six-inch regulator can actually be closed in a fraction of a second by this method.

Briefly, that describes control features which are available in self-contained regulators which can be of ma-

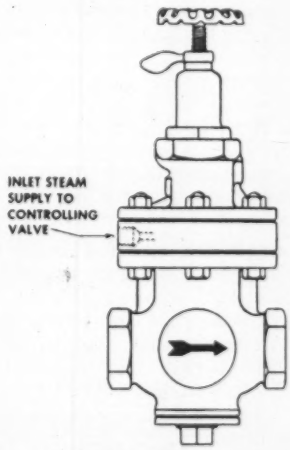

Fig. 11. Self-contained Regulator with External Supply Pipe to Pilot Valve

terial benefit to most instrument engineers by simplifying the solution of a great many regulation problems.

Simplified Control Pilot

Our conception of a simplified, economical air- or water-operated controller is illustrated by the control pilot in Fig. 12, which is extremely rugged, yet sensitive and accurate, and uses air or water only when a load change occurs which regulates an increase in diaphragm pressure. This control pilot utilizes basically the same principle of operation as the self-contained internal-pilot piston-operated reducing valve but employs an external medium such as air, water or light oil to operate a diaphragm and reposition the main valve rather than using the fluid passing through the valve itself.

The controlled pressure is felt by a diaphragm which is balanced by an adjusting spring. The movement of the diaphragm, only 0.040 in., is transmitted through a rod, nozzle disk and nozzle to a pilot valve which regulates the supply of operating medium to the diaphragm of the regulating valve. In the control pilot in Fig. 12, which is direct-acting, (that is, an increase in the controlled pressure causes an increase in operating pressure) when the controlled pressure on the diaphragm goes above the set point, it will open the pilot valve and increase the pressure to the diaphragm of the regulating valve. When the controlled pressure on the diaphragm of the control pilot drops below the set point, it permits the nozzle disk to relieve pressure through the nozzle after the pilot valve has closed and thereby reduce the pressure acting on the diaphragm of the regulating valve.

When the controlled pressure balances the setting of the adjusting spring, both the nozzle disk and pilot valve are closed, maintaining a static pressure to the diaphragm of the regulating valve and, under this condition, no air or water is being consumed. Only an increase in controlled pressure above the set point will open the pilot valve and use air or water to stroke the diaphragm regulating valve. During this time, the nozzle disk is closed and no air or water is bled to atmosphere.

The nozzle nut is adjustable in the field, so that the relative time of closing of the pilot valve and opening of the nozzle disk can be set to meet the requirements of each job. Normally, it is

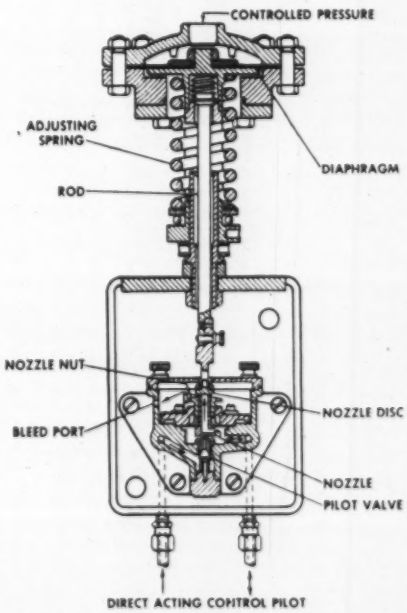

Fig. 12. Control Pilot, Air- or Water-operated

adjusted so that the pilot valve seats just as the nozzle disk opens. This permits close control for most applications without allowing any direct flow of air from the source to atmosphere. If delayed action is wanted, pressure lag can be set between the closing of one and the opening of the other. Or, for supersensitive control, the nozzle disk may open before the pilot valve reaches its seat.

Since this control pilot is either supplying pressure to the diaphragm of the regulating valve or bleeding pressure

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from it, except when the diaphragm is in the neutral or balanced position, it also simulates the action of a valve positioner which is often required with conventional design pilots. That is, whenever the controlled pressure is above or below the set point this control pilot will continue to increase or decrease the pressure to the diaphragm of the regulating valve until balance is restored. It has a high air output per second (3 to 5 times greater than conventional flapper types for sudden load changes) thereby quickly repositioning the diaphragm regulating valve even though stem friction may be greater than normal. This feature assures positive, accurate control on many jobs without the additional complexities of a valve positioner, without continuous use of compressed air and with a rugged, reliable construction which will withstand shock and vibration without requiring readjustment or calibration.

And, as previously indicated, if compressed air is not readily available,

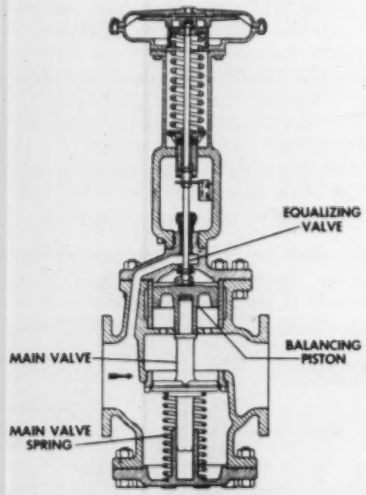

Fig. 13. Diaphragm Regulating Valve, Single-seated, Balanced Design

clean water or light oil can be used and there will not be a continuous waste of the operating medium.

This pilot can also be furnished reverse-acting where an increase in controlled pressure results in a decrease in operating pressure to the diaphragm of the regulating valve. Diaphragms and springs are available for standard controlled pressure ranges from 30 in. Hg vacuum to as high as 800 psi. and for controlling constant differential pressures from 0.5 psi. to 75 psi.

Single-seated Balanced Valves

A feature of the diaphragm regulating valve in Fig. 13 which can be used with any air- or water-operated controller is that it is fully balanced to handle any pressure differential and is single seated, tight closing. For example, a 4-in. single-seated valve of this design can be opened against 600 psi. pressure with only 5 psi. air pressure.

The balancing is accomplished by the use of a piston having the same area as the main valve and a small equalizing valve which admits inlet pressure to the top of the piston. The first downward movement of the stem opens the equalizing valve. The end of the stem then contacts the top of the piston and since there is now equal pressure below the main valve and on top of the piston, it is only necessary to overcome the force exerted by the main valve spring and the main valve will be repositioned for very small air pressure changes.

These valves are designed to start opening between 3 and 5 psi. air pressure and to be fully open between 15 and 18 psi. air pressure. As the valve closes, the main valve seats first, pressure under the seat, then the equalizing valve, which is also single-seated, closes and dead-end shut-off is assured. These diaphragm regulating valves also include hardened stainless steel valves and

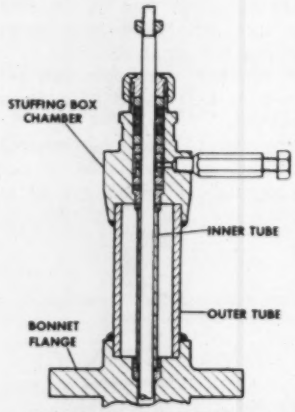

Fig. 14. Conden-seal Bonnet

cylinder liner and stellited seats for both the main valve and equalizing valve as standard equipment. They are available in semi-steel and bronze construction in sizes from 2-in. to 10-in. inclusive and in cast steel construction from 1¼-in. to 8-in. inclusive.

For services where the pressure drop is not sufficient to require balanced construction, single-seated needle plug, quick-opening or V-port valves are furnished.

For temperatures above 500 F., the "Conden-seal" cooling bonnet shown in Fig. 14 is recommended. This is a unique design which results in stuffing box temperatures 100-200 F. lower than the conventional finned design cooling bonnets. It is constructed of two stainless steel tubes. The outer tube is welded to the body bonnet flange and stuffing box chamber and the inner tube is connected to the bonnet flange only. The stem is a slip fit in the inner tube and as steam passes up the inner tube it condenses and fills the outer tube until a full liquid seal forms between the bonnet flange and the stuffing box. The outer tube is of stainless steel, the cross-sectional area of which is small in comparison with its radiating surface area. This ratio and its low thermal conductance and small mass minimize the conduction of heat from the bonnet flange to the stuffing box and insure a subcooled liquid seal. Even when handling hot gases where there is no condensate, it is very effective owing to this low thermal conductance and the small mass of metal involved to transmit heat from the body.

To make a direct-acting body assembly reverse-acting, or to make the reverse-acting single-seated balanced design direct-acting, the reversing superstructure shown in Fig. 15 can be applied to either body assembly

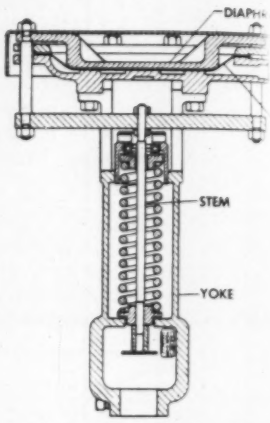

Fig. 15. Reversing Superstructure

replacing any parts or without removing either the top cap or bottom cap of the diaphragm regulating valve. The air pressure is applied to the underside of the diaphragm and its movement is transmitted from the diaphragm disc through a yoke to the stem and valve. There is no stuffing box in this diaphragm head and the travel and effective area are identical with that of the direct-acting superstructure size for size. With this superstructure, a direct-acting body assembly becomes normally-closed and a reverse-acting body assembly becomes normally-open by a simple exchange of top works.

Conclusion

Now, when should these air- or water-operated controllers be used in lieu of a steam pilot? As previously explained, a great many control problems can be handled as well or better with well-engineered and properly-built self-contained regulators. But, for services involving extremely intermittent operation or stand-by control, an air- or water-operated controller will give more dependable results than a regulator employing either an internal or external steam pilot since under intermittent flow conditions, particularly at low reduced pressures, the effect of water and condensate which will fill up the regulator when it is closed for a period of time will tend to make it sluggish and may result in less accurate regulation.

Where extremely sensitive response to small variations in controlled pressure is required, the air- or water-operated controller will do a better job than the self-contained regulator.

But, whatever the problem, it is always wise to be sure that a particular regulator is recommended by the manufacturer for a given service before it is installed or before it is condemned once it has been installed.

Unorthodox Pneumatic Circuits Make Simple Standard Devices Perform Extraordinary Jobs

By RALPH D. WEBB, Instrument Supervisor, Carbide and Carbon Chemicals Corp., South Charleston, W. Va.

SOME seven or eight years ago, one of my men sidled into my office and shyly handed me a small wooden plaque (Fig. 1) which he had made for me and carefully lettered: "Livin' caint be simple enymore—they's too many gadgets."

This plaque has had a special spot on the walls of my office all these years, and now, today, when all the world has

Fig. 1.

learned how true this statement is, I greatly prize it. So my theme will be about those gadgets—and gadgeteering.

By "gadgeteering" we instrument men commonly refer to an unusual and unorthodox hook-up of instruments—especially if the hook-up is tricky. No man in this field of work can resist the temptation of gadgeteering—nor can he well afford to refrain from it!

The instrument or device which we have found most susceptible to use in unorthodox ways is the Valve Stem Position Controller. I call it that, rather than its conventional name—valve positioner—just to emphasize the fact that it in itself is an automatic controller, although from here on I shall refer to it as a valve positioner. Now, remembering that it is an automatic controller, let's look into the bag of tricks that we have developed for it.

I believe I'm safe in asserting that the positioner we used was not intended by its designers to do any of these tricks. Furthermore, I do not want to leave the impression that just because I refer to but one make of positioner it is the best or only one for this kind of gadgeteering.

Portions of this article were presented by the author at the Short Course on Instrumentation for the Process Industries, October 1948, Texas A. & M. College; other portions (including four new illustrations) were prepared especially for *Instruments*.

One of our early expedients along this line—back in 1935, I believe—was that of using positioners to operate multiple valves in sequence with but a single controller. Fig. 2 shows our way of doing this. An intermediate-pressure or low-pressure steam header is maintained at a quite constant pressure regardless of whether or not the steam consumed by the stills and that produced by the compressor exhaust are in balance. Note that the over-all action of the valves as shown by the air pressure settings calls for the make-up valve to be air-to-open and the vent valve to be air-to-close. But the men who must operate this plant may feel that BOTH valves should close in the event of a general failure of the instrument air supply. This is achieved by using an air-to-open vent valve and then interchanging the bellows and its opposing spring in the positioner to give the action originally shown. The valve will still open with decreasing air pressure from the controller but naturally must close if the air supply to the positioner drops to zero. About 1935, this was unorthodox and could be done with but one make of valve positioner.

Often, control valves riding close to their seats will tend to plug by having their port openings bridge over with suspended solids. We figured that if we could pulse the valve at a relatively high frequency, we would prevent this tendency to bridge and plug. This was a "natural" for the gadgeteer. We altered the positioner to do just that. Fig. 3 shows schematically what we did.

As stated earlier, the positioner is a controller. Normally it is a narrow-band proportional controller. Our addition of the bellows below the nozzle upset the usually smooth and accurate positioning of the valve stem, for each time the flapper approached the nozzle this little bellows huffed up and pushed the nozzle hard against the flapper, causing, through the usual chain, the value stem to move down quickly. This, in turn, caused the flapper to withdraw, but, just as soon as the space between the flapper and nozzle became a few thousandths of an inch, this same bellows violently pulled the nozzle away from the flapper, thus reversing the movement of the valve stem. A pulsing or pumping or "dithering" cycle was set up—all without any change in pressure of the air from the main controlling instrument. The amplitude of the cycle is adjustable by varying the stroke of the little bellows and by linkage changes;

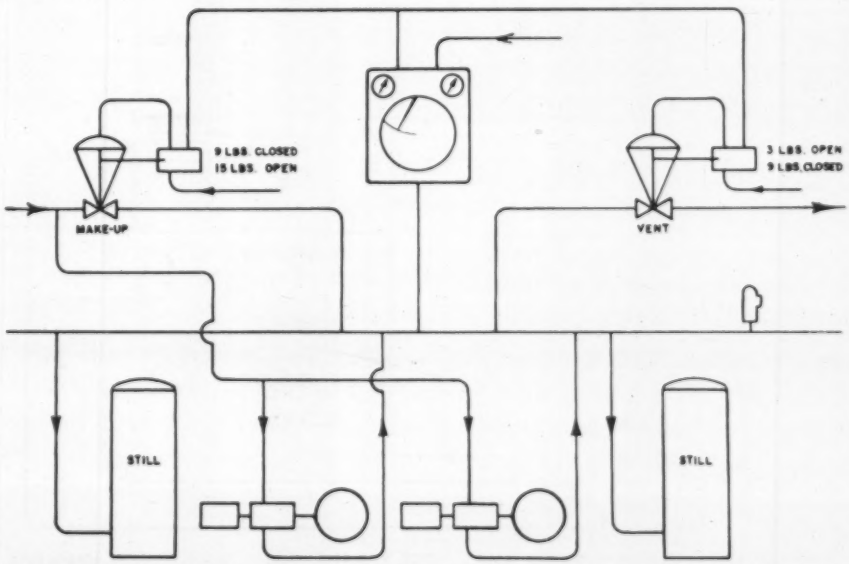

Fig. 2. How to make one automatic-control instrument do the work of two. This bit of gadgeteering has worked perfectly since about 1935.

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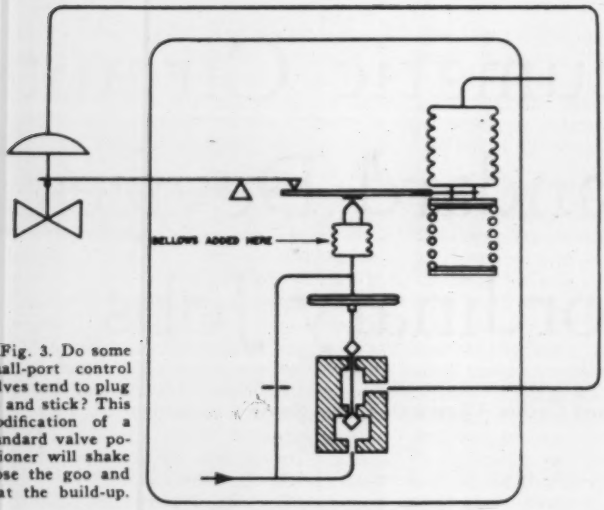

Fig. 3. Do some small-port control valves tend to plug up and stick? This modification of a standard valve positioner will shake loose the goo and beat the build-up.

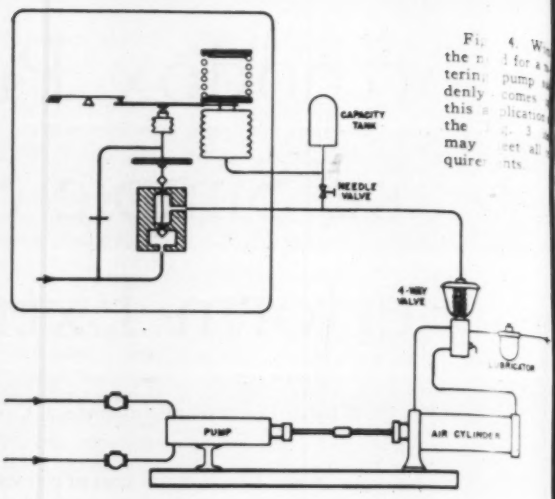

Fig. 4. W... the ... for a ... terin... pump ... denly ... comes ... this ... plicatio... the ... 3 ... may ... set al... quire... nts.

the period by means of a variable resistance or restriction in the air line to the valve diaphragm.

Dosage Controller

Readers will recognize, I believe, that the device just described is nothing less than a pneumatic oscillator. As such, we found many uses for it and Fig. 4 shows one extremely useful practical application. We disconnected the positioner from the motor valve and fed the output of its relay to a four-way valve that controlled the air to the power cylinder of a small plunger type pump In the original application, the pump was used to inject a controlled amount of chemicals into one of our reactors and we found that, by proper sizing of the needle valve and of the capacity tank, we were able to calibrate the needle valve settings versus the pump output from zero to 10 gallons per hour. We were able to duplicate this calibration within a few percent time and time again, and so found that unit very practical for experimental and development work. The positioner was mounted on the air cylinder, thus giving a portable pump that could be moved around the plant freely and safely.

Position Transmitter

A need occasionally felt in plants such as ours is that of a transmitter of mechanical position. Say we want to independently transmit the stem position of a very important motor valve back to the control room. All that is necessary is to take our old friend here and do as shown in Fig. 5: tie the relay output back to the main bellows. This is a handy gadget to have available. We use it on ball floats to transmit position; we use it on variable orifices to transmit and subsequently to record the orifice settings; we have even used it to transmit the position of the scale levers in weigh tanks.

Valve Tester

Soon after we developed this position transmitter, we found use for two of them in the valve testing system shown in Fig. 6. One of the transmitters—t... upper one as shown on the drawing—... was used to pick up position as p... duced by a rotating cam and translati... this position to 3 to 15 pounds air pre... sure. The cam was rotated by a sy... chronous motor at the rate of one rev... lution each 15 minutes, and its sha... when developed was that shown at t... bottom of the figure. It caused the a... pressure to rise to four peaks—one pe... at 6 pounds, one at 9, one at 12, and t... final one at 15 pounds. Each time, t... pressure would rise at a given rate an... then would reverse itself and drop a... least 1½ pounds. The whole cycle wa... completed in 15 minutes. The air pres... sure produced by this first transmitte... was recorded by one pen of a two-pe... instrument whose chart rotated at th... same speed as did the cam. This same ai... pressure was fed to the top of the moto... valve that we wished to test for frictio... or dead spots. The actual movement o... the stem of the motor valve was in tur... picked up by the second position trans... mitter, whose output was recorded b... the second pen on the same chart alon... with that of the first transmitter. Thes... two records would be almost identica... if no friction existed in the motor valv... being tested. However, if friction ex... isted in the motor valve at any of th... points of reversal of motion, then th... second record—the record produced b... the second transmitter—would show ... plateau during the time that the valv... did not respond to the air pressur... change being imposed on its diaphragm... It is thus quite easy to measure th... amount of dead spot that exists at fou... different points on the stroke of a valv...

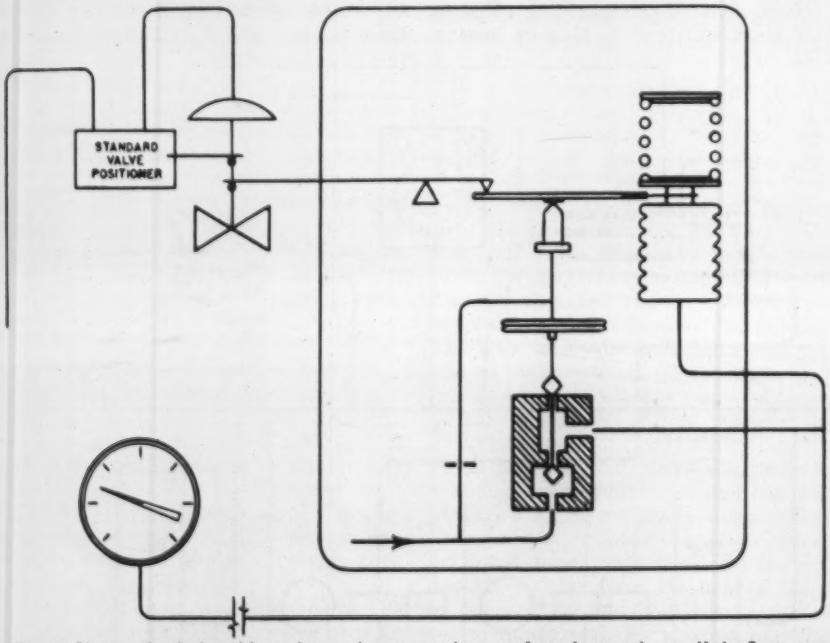

Fig. 5. If a mechanical-position telemetering system is wanted on short notice, or if the Instrument Department's budget will not allow ordering a standard commercial position transmitter, here is the answer.

Pneumatic Switch No. 1

We can take this same device that w... have used as a position transmitter an... with slight alterations, convert it in... an adjustable lever type pneumat... switch. Fig. 7 shows how we have tak... the positioner, mounted on a mot... valve and, by disconnecting the fe... back to the lower bellows, we ha... achieved an off-on or snap action. N... at some given position of the va... stem, we get full air pressure chan... on the output, which change can ... made to do any of several things; f...

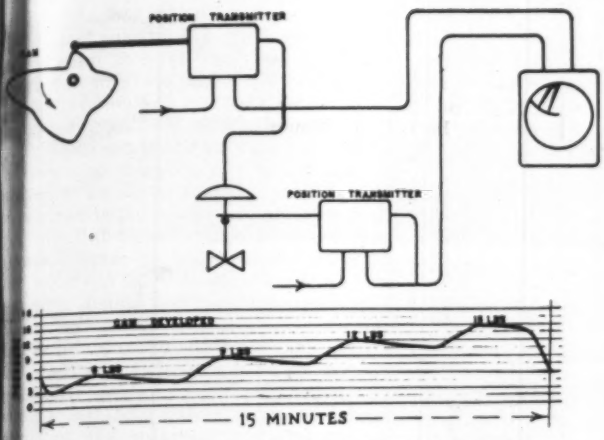

Fig. 6. Simple standard "air-op" components, plus ingenuity, go to make an excellent hysteresis testing system or time-cycle control system.

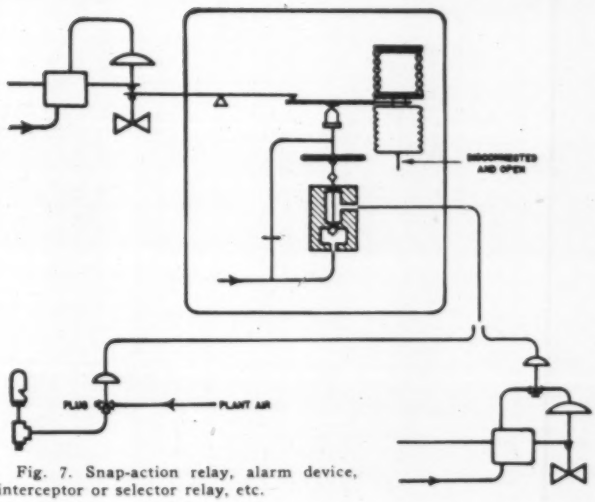

Fig. 7. Snap-action relay, alarm device, interceptor or selector relay, etc.

stance to blow a whistle as indicated the figure, or to cause another motor lve to assume an open or closed posi-n.

Pneumatic Switch No. 2

Taking this same hook-up, but with pivot of the mechanical feedback er held rigidly, as Fig. 8 shows, and h the bellows pressure coming from e other controller, we can set this ice to give a full change in output ssure—and in either direction—at desired pressure on the main bel-s. With this, snap action can be ieved at any point in the 3-to-15-nd control band. This is a very pop-r gadget up our way. For instance, will connect the bellows of this de-e to the output pressure of the con-ller. When the air pressure reaches of its limits—15 pounds, for in-nce—this can be made to sound an rm, thereby warning the operator t the unit has gone out of control; should the main controlling instru-nt be a liquid level device, it can be d as a high-level or low-level alarm. ng capable of exact setting, it has n found to be a thoroughly reliable dition to our plant.

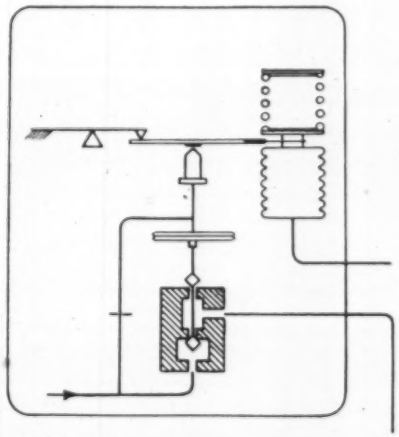

Fig. 8. This pneumatic snap-action relay won popularity because of its flexibility and highly-precise adjustability.

Large-valve Operator

Early in the war we got into a minor n in one of our steam generating tions. A large expansion valve need-to be changed over from reducing to k pressure service. The hitch was t the valve required a very low range its piloting mechanism—a matter of ew inches of mercury. The only spare trollers we had were of the standard output range which was approxi-tely four times that of the valve t. So we took one of our old faith-s and operated on it a bit. Fig. 9 ws what we did: the lower and upper lows were of 2-inch and 1-inch meter respectively, giving us a 4-to-1 uction in pressure. We had in essence four-to-one step-down pneumatic nsformer that operated smoothly, h no measurable dead spot. It worked from the start and, so far as I w, is still in service.

Compressor Control

A need which is met today with a standard instrument—but which to our knowledge was not met a few years back—was that of a selector relay which would preferentially cut in whichever of two controllers tended to close, or to open a given motor valve. A common example of such a need is that of a gas compressor with a controller on its discharge pressure commanding a valve on steam to the power end. Should the suction pressure of the compressor drop too low, it is often desirable to slow down the compressor regardless of the discharge pressure going low, but still the latter must take over automatically in case it goes above the set point.

Our answer was again found in our old gadgeteers' friend. This time we needed a little help from a small air-actuated three-way valve, as seen in Fig. 10. Note that again we have the little bellows under the nozzle to assure snap action so that the three-way will not float between the two controller outputs. By careful adjustment we were able to make the motor valve swing

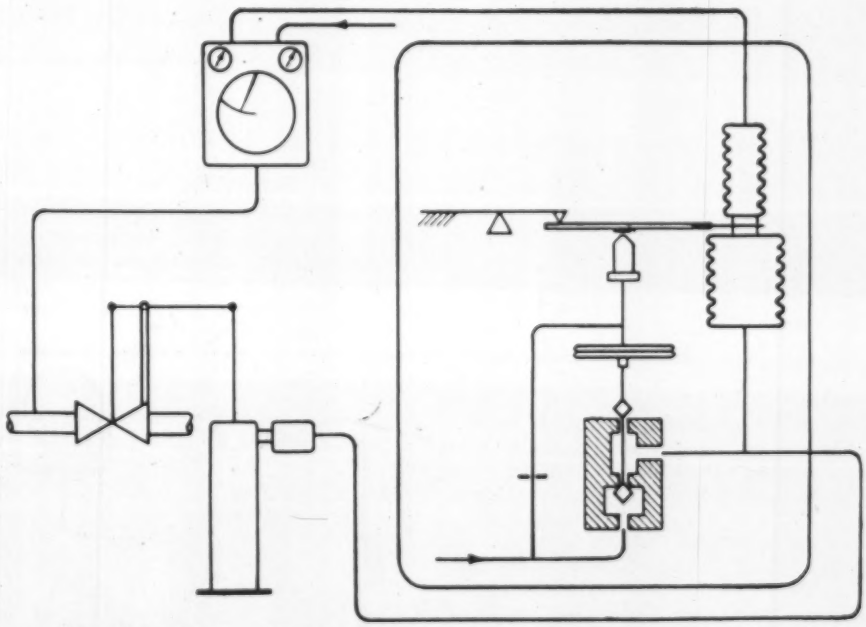

Fig. 9. This unusual adaptation of the valve-stem positioner—the pneumatic analog of an electrical step-down transformer—gave complete satisfaction.

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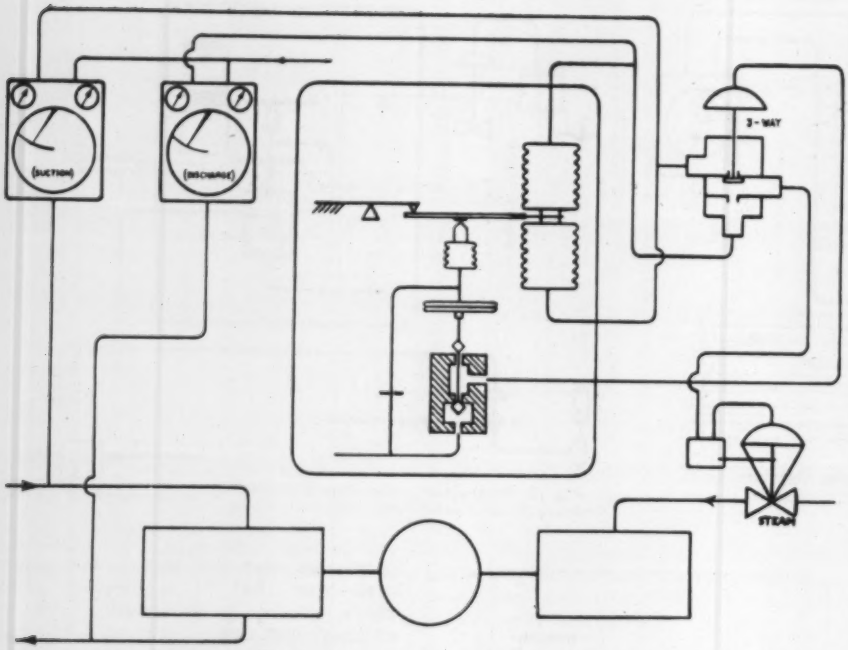


Fig. 10. Showing how a dependable safety feature was added to an automatic-control system in an unorthodox—but effective—way.

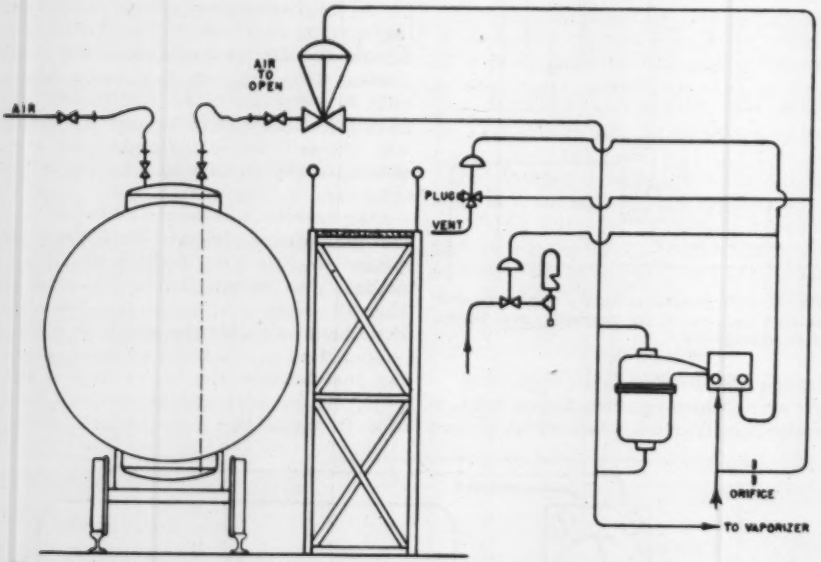


Fig. 11. Another safety-aimed hook-up, as unorthodox as the others but involving a liquid-level controller instead of a valve positioner.

to the non-controlling instrument output when the latter dropped as little as two or three inches of water below the other.

In one instance, we used this selector relay hook-up on a steam driven compressor, but, in place of the suction controller shown in Fig. 10, it was desired to make the speed of the compressor one of the limiting factors. The compressor was already equipped with a Pickering governor. To this our men adapted a position transmitter, described before in this article, thereby achieving an air output proportional to speed. This was hooked into the selector relay and, whenever the compressor came up to its maximum speed, this device automatically took command of the motor valve on the steam line and kept the compressor from overspeeding.

Safety Filler

I suspect that none of the other standard instruments lend themselves to gadgeteering as well as does the valve positioner, but, just to show you that there are others, let me describe what we did on a chlorine unloa ing jo Here (see Fig. 11) we ha used standard buoyancy type of li uid le controller. When the operator as pr sure up on the car and his alves lined up, he places his finge over t little vent pipe on the three-w y val thus causing air pressure t build the motor valve. The liquid chlor then fills the line to the vapor er, ca ing the level controller to fil there building air pressure on the hree-w and on the whistle valve. This takes b a few seconds—not too long a time f the operator's finger. When the car empty, air enters the unloading line a causes the level controller to actuate t two small diaphragm valves. The ma motor valve is closed and the whis sounds off. The operator has to cli up a rack to shut off the whistle means of the little automatic reset va shown below the whistle. This applic tion of standard items in such an u orthodox manner really works. It ge all of the chlorine out of the cars a has often saved the plant chlorine sy tem from undesirable—perhaps dange ous—shots of air.

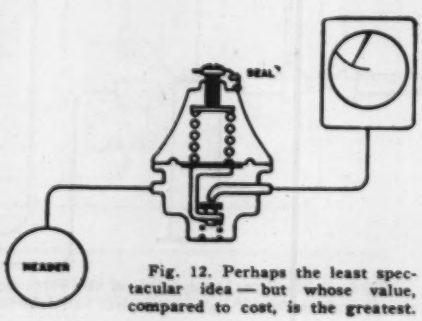


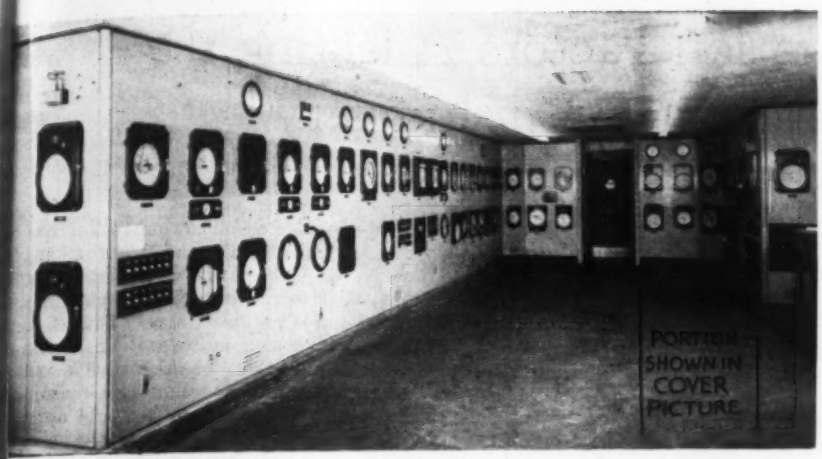
Fig. 12. Perhaps the least spectacular idea — but whose value, compared to cost, is the greatest.

Instrument Protector

By way of contrast with the rath complicated grouping of devices just d scribed, let me show a rather unorth dox use of the simple little reducin regulator such as is often employed t furnish reduced air pressure to our in struments. There is often need to ad some protective device to low-pressur elements in recorders and recording co trollers, where, during shutdown or i cases of emergency, pressures well be yond the allowable limit of the pressur element can be expected. Here, as show in Fig. 12, we have used the simpl quarter-inch reducing regulator in th line, but have reversed it in respect t the usual concept. Note that the sourc of pressure—the header indicated in th figure—is connected to what is conven tionally the downstream side of the reg ulator. Should this header pressur reach a dangerous point, the regulato is so adjusted (and, incidentally, sealed that it closes off the side connected t the instrument and keeps it closed o as long as the header pressure is abov a designated maximum. As soon as thi pressure drops below this point, how ever, the valve automatically opens, per mitting the correct pressure to go t the instrument. The type of regulato normally used is fitted with a composi tion disk which gives quite tight shut off and we have found it a thoroughly reliable means of protecting the pres sure elements of our instruments. This is a simple bit of application, which can hardly be considered spectacular a perhaps we might consider the chlorin unloading job, nevertheless it is one tha shows that unorthodox usage is appli cable all the way down to the smalle items used by the instrument man.

* * *

It is natural for the instrument me chanic and his boss to work to insta instruments using trick hook-ups. Th is good and will be profitable if ke under control.



General view of the Central Control Room, Pittsburgh Plate Glass Company's chlorinated benzene plant. This month's cover photo shows the automatic time-temperature program control instruments for separation of high-purity paradichlorbenzene.

Processes Completely Automatized in New PPG Chemical Plant

I—GENERAL

NATRIUM, W. Va., July 21, 1949—A chlorinated benzene producing plant has been placed in operation here by the Columbia Chemical Division of Pittsburgh Plate Glass Company . . . The new plant will produce monochlorbenzene, muriatic acid, paradichlorbenzene and orthodichlorbenzene as co-products in a continuous chemical process. Production of the chlorinated benzenes, basic chemicals in the organic field, marks the Columbia Chemical Division's entry into the field of organic chemical compound production. In the manufacturing process, somewhat similar to oil processing, substantial chlorine tonnage will be consumed daily. Supplies of benezene will be transported by river shipment from the coking ovens of Wheeling, West Virginia and Pittsburgh steel mills. The plant is well located both for its raw material sources and proximity to the markets for its products. For close control of the operation of process equipment and quality of the products an excellent job of instrumentation has been accomplished at the new plant.

II—INSTRUMENTATION

(Written especially for *Instruments*)

The new modern chlorinated benzene plant of Pittsburgh Plate Glass Company at Natrium, West Virginia is controlled automatically by instruments throughout — from feeding and drying raw benzene through chlorination and separation to purification of end products. All processing equipment is protected with safety instruments and interlock controls which isolate critical units in event of emergency.

Operations are conducted from a central instrument room where all processing is coordinated automatically. Some unit operations are completely self-supervisory, requiring only the manipulation of a "start" switch: equipment is charged automatically, side products of specified purity are withdrawn, and end products processed to purity specifications and discharge, and operations terminated or repeated automatically as preferred.

The instrument-room wing of the administration and shipping building is arranged in a convenient "capital-J" pattern overlooking the entire out-of-doors processing area, thus enabling operators to view equipment and instruments from a common vantage point.

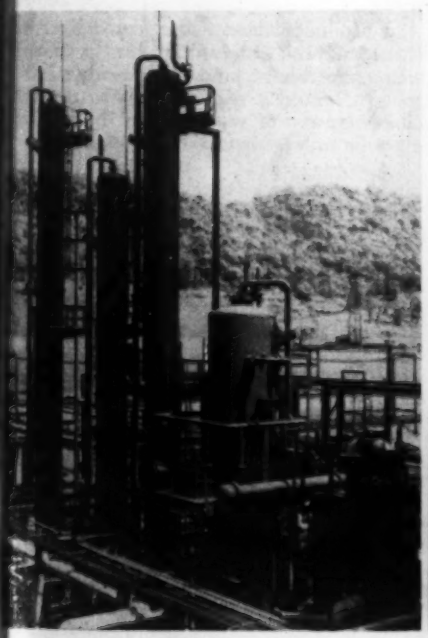
Instrument ranges have been specially selected to enable operators to detect, at a scanning glance, an "out-of-line" unit.

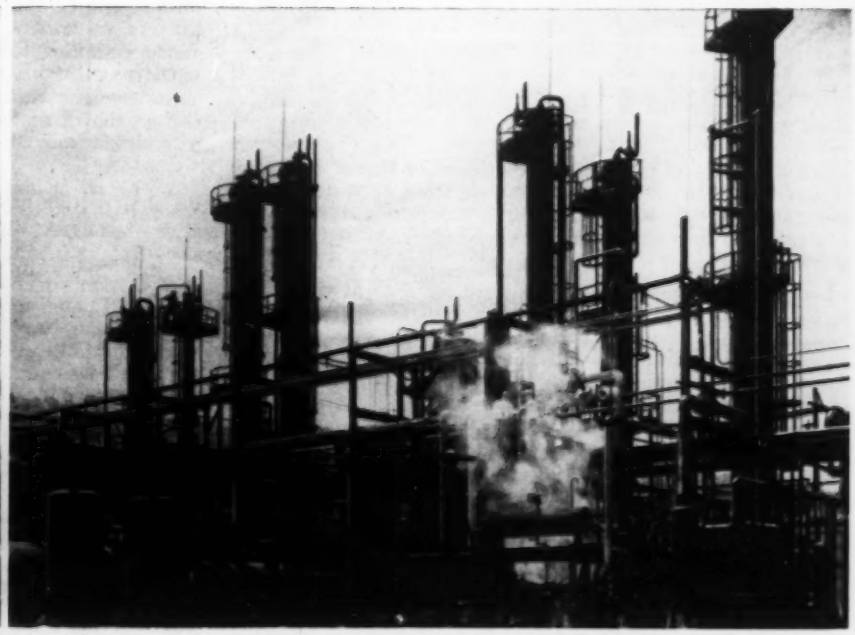
Transmitters are used throughout the processing area. No fluid other than instrument air and electric power from field transmitters enters the central instrument room. The processing area and instrument room are served independently by regulated air headers from a central supply and reducing station.

Resistance thermometers and thermocouples are used for all temperature processes.

Material and energy balances are regulated and metered; process inventory, utility and product accumulation are metered with instrumentation having standardized designed constants in keeping with instrument code standard, thus providing complete flexibility and interchangeability.

EDITOR'S NOTE: *Knowing that these 300 words will make our readers want details, we are arranging for a full-length technical article.—MFB*





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Some Application Factors Affecting *the* Regulation *of* pH *in* Industry

By ALLEN L. CHAPLIN, Consulting Engineer

III—THE RESIDENCE SYSTEM

To the chemical process engineer, residence is comparable with capacity to the control engineer. Some engineers speak of it as "flywheel action" while others refer to it as inertia, but, regardless of conflicting terminology, it is used for essentially the same purpose by all engineers; with the possible exception of its effect upon the concentration gradient of a chemical process.

The general effect of residence is to establish *concentration gradient* in a process and introduce stabilization into the control system. It functions as an exponential generator and converts linear changes in concentration of the influent into exponential changes in concentration of the effluent. There is

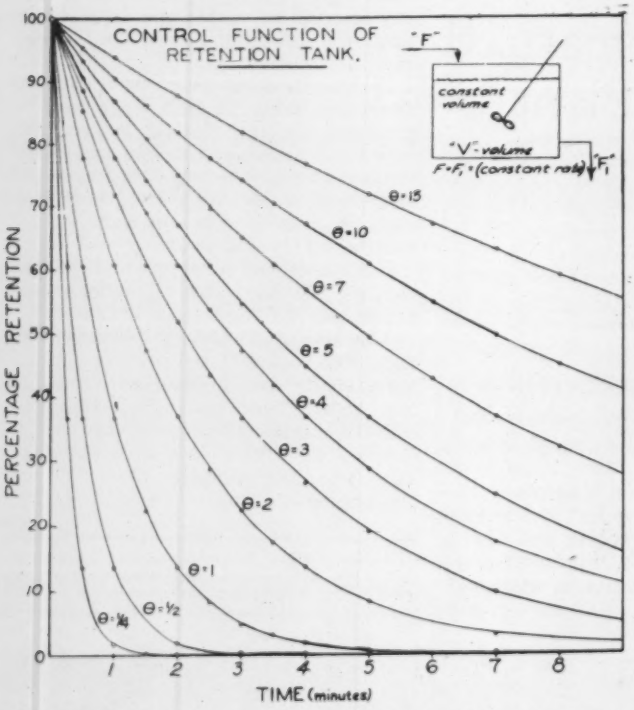

Fig. 29. A residence system is an exponential converter. It converts LINEAR changes of influent concentration into EXPONENTIAL changes in the effluent. The rate of conversion is controlled by the retention (θ) of the system.

a definite physical relationship between the size of tank, the throughput rate and influent concentration as expressed by the following equation; assuming absolute uniformity of contents and zero short-circuiting:

$$C/C_0 = e^{-t/\theta} \quad \ldots\ldots (3)$$

where C is the concentration of tank contents at time t; C_0 is the initial concentration at time $t=0$; e is the base of natural logarithms, and theta (θ) is the tank retention in time units comparable with t. Theta may be expressed as the ratio of tank volume (V) in gallons to throughput rate (F) in gallons per minute:

$$V/F = \theta \quad \ldots\ldots (4)$$

A graphical illustration of this effect is given in Fig. 29 which expresses the percentage retention, by the residence, of influx material at any time t for various values of retention theta. For example, a residence having a retention $\theta=1$ would, at the end of three minutes, retain 5% of the original influx material. Maintaining throughput constant and increasing retention to $\theta=2$, the system retains 22.5% of influx material in the same time interval; a retention $\theta=10$ retains 73.5% of influx at the end of three minutes.

The stabilizing effect of residence on concentration changes in a process is evident from the above; and it is further obvious that a retention system is, by virtue of the law of residence, an efficient and effective controller of effluent concentration if the influent stream is regulated. Some writers have classified a flow-ratio controller as a *concentration* regulator and, in the same manner of analysis, have regarded a single-flow regulator as a *transportation* controller. This reasoning cannot be substantiated by the above and it would appear from an understanding of the laws of residence, that simple flow regulators which control the influent stream to a residence system can be regarded as concentration controllers on an equal basis with flow-ratio regulators.

More important in a pH control process however, is the effect of the concentration gradient of a residence on the so-called "decomposition rate" of chemical reactions which take place within the system. It is this factor which establishes the exception to similarity of the process engineer's residence factor and the control engineer's capacity factor.

The foregoing pertains only to the holding time and concentration gradient of a residence and does not tell us anything about the course of chemical reactions which take place within the system to cause a change in pH. Bearing in mind that chemical reactions are dependent upon the *concentration* of reactants, and that this varies exponentially in the control tank, it is apparent that the rate of change of pH (hydrogen ion concentration) will be dependent upon the residence factor (V/F) and the so-called "order of reaction."

Reactions which cause the change in pH may be classified in terms of First Order, Second Order and Third Order; and, if we wish to size the control tank to effect a prescribed damping of a load change, we must take into account the order of reaction and its velocity coefficient.

A first order reaction may be defined by the equation

$$dc/dt = -kc \quad \ldots\ldots (5)$$

where c=concentration of reacting material
t=time
k=velocity coefficient.

and the process is isolated as a batch system where concentration of reactants is affected only by the chemical reaction. In a continuous process, however, the concentration of reactants is augmented by the rate of feed and reaches an equilibrium value with the product effluent as affected by residence action of the control tank. If feed of reactants and withdrawal of product are constant, and if we evaluate the actual weight change of reactants with respect to time, it can be shown that concentration of reactants in the effluent of a single-tank continuous process is

$$C_1 = C_0/(1+k\theta) \quad \ldots\ldots (6)$$

or, the fraction emerging "decomposed" or reacted

$$D = 1-(C_1/C_0) = 1-[1/(1+k\theta)] \quad \ldots\ldots (7)$$

Comparing equations (5) and (6) it can be seen that "decomposition" of reactants, for a given concentration (C_0), differs in batch and continuous processes. The resultant pH changes are dissimilar, and we could expect an applied pH regulator to behave differently in the two systems. The continuous flow equation (6) contains the retention factor (θ) which determines the reaction rate of a controller applied to a continuous control system, whereas the batch equation is independent of this factor.

It can be further shown by integrating equation (5), that

$$C_1/C_0 = e^{-kt} \quad \ldots\ldots (8)$$

and

$$D = 1-e^{-kt} \quad \ldots\ldots (9)$$

from which we find that a continuous process behaves similarly to a batch when its nominal holding time is equal to the reaction time.

A second-order reaction may be defined by the equation

$$dc/dt = k(A-x)(B-x)_L \quad \ldots\ldots\ldots\ldots (10)$$

where A and B are initial concentrations of the reactants, and x is the *equivalent* loss in concentration of each reactant as a result of reaction.

In the special case where $A=B$, equation (10) reduces to

$$dc/dt = -kc^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots (11)$$

for batch reactions, and to

$$C_0 = C_1(1+k\theta C_1) \quad \ldots\ldots\ldots\ldots\ldots\ldots (12)$$

for a continuous control tank.

As the order of reaction increases to third order, the computations become involved beyond practical gains for this discussion of *application* factors and offer no advantage over graphical methods for solution of the engineer's control problems.

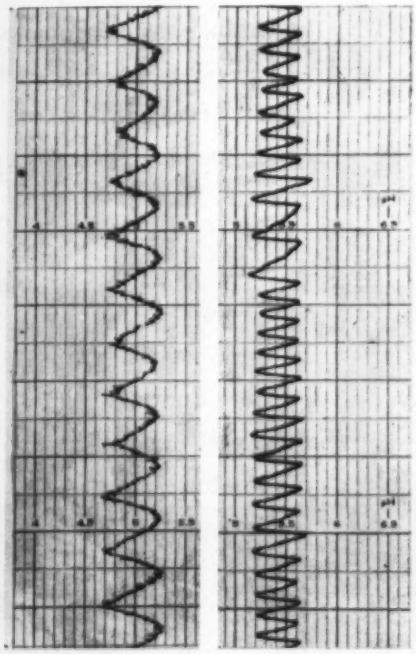

Fig. 30. Control record produced by process of Fig. 31-A. containing large residence in control loop of proportional regulator. Left chart, control point 5.0 pH: Right chart, control point, 5.4 pH. Note characteristic indication of equilibrium lag in left-hand record.

The practical importance of the foregoing treatment to the control engineer who applies concentration-measuring instruments to a process, is to show that a fixed relationship exists between the rate of concentration change in the system and its residence factor. The system does not in all cases behave simply as a surge vessel which follows only physical laws, but has superimposed the added variable of "decomposition" reactions.

If the chemistry of a residence reaction is known, it is possible to calculate the required dimensions of retention to obtain a desired end result and the volume so derived will have a definite reaction period. Having attained an optimum retention for a given pH control job, its reaction period will be affected by (1) a change in composition of influent; (2) a change in volume dimensions of residence; and, in some cases, (3) a change in temperature and/or pressure of the system.

A change in any one condition may cause the regulator to hunt, but the greater the magnitude of any or all of the above conditions, the smaller is the effect of changes in any one. It is apparent therefore, that a pH control system should be supplemented with a means for controlling level in the control tank and, if the influent pH load is subject to wide fluctuations, either (1) the tank should be large enough to handle the worst condition (which is sometimes impractical from a cost standpoint); or (2) a two-stage or multiple-stage residence should be used; or (3) cascaded control systems (which have flexibility and favorable cost advantages) should be applied.

The retention tank is a convenient and useful tool to the control engineer and provides an easy way out of many difficulties. As a matter of fact, if many existing installations of pH control were seriously analyzed, it would be found that the tank is contributing more toward regulation of the process than the applied regulator. Reaction rate of the majority of pH control applications is considerably greater than corresponding reaction rate of the conventional regulators, and sometimes it is necessary to weight the process with inertia (capacity) to reduce its rate response in keeping with requirements of the regulator.

It was pointed out above that a residence system has a fixed period of oscillation and that the regulator must be adjusted to a corresponding period. This principle is borne out by the process illustrated in Fig. 31-A which consists of

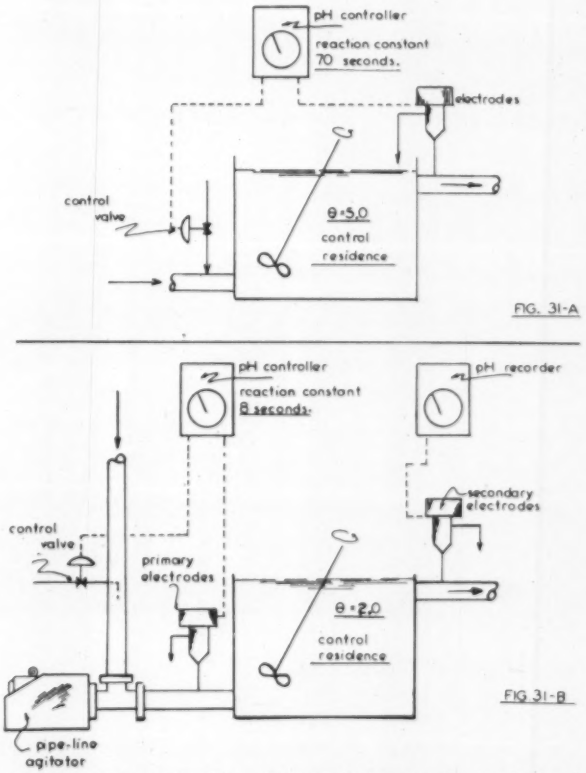

Fig. 31. High-speed pH regulator applied to pipe line control reduces size of control residence required by low speed regulator and may improve regulation.

a large tank ($\theta=5$) and a proportional-position pH controller applied in the conventional manner. The regulator, as originally installed, was a standard commercial pH regulator of the electric type having a valve-stroking constant of 70 seconds. It was not possible to obtain any acceptable degree of regulation with this equipment: its reaction constant was so far below the process constant that the latter "ran wild," and, in reality, controlled the regulator. However, by increasing the reaction constant of the regulator in incremental steps, an optimum value of 25 seconds (full stroking time) was found, beyond which no appreciable gain resulted. A limiting condition had been reached which represented the maximum gain of a proportional regulator under the existing conditions of load variations and the fixed residence. The best available control from this system was a cycling record having a total band width of 0.4 pH (Fig. 30).

There was theoretical evidence to support the use of derivative regulators under such conditions, but results of the immediate problem were improved by rearranging the process and applying the proportional regulator in another manner: The residence was replaced by an unused adjacent tank of retention approximately $\theta=2$ and the regulator applied as indicated in Fig. 31-B. A pipe-line agitator was installed near the tank inlet and the reagent feed valve located approximately two feet upstream. The control elec-

Continued on page 734

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TECHNICAL PROGRAM

Instrument Society of America — American Institute of Physics — Institute of Radio Engineers
American Society of Mechanical Engineers — Scientific Apparatus Makers' Association
American Institute of Electrical Engineers — National Telemetering Forum

Monday, Sept. 12—10 A.M.

I.S.A. Open Meeting

The Annual Business Meeting of the Instrument Society of America is scheduled for Monday, September 12th at 10 A.M. in Room 1, Municipal Auditorium. All members and visitors to the Fourth Instrument Conference are urged to attend this important meeting, which provides an opportunity to meet the National Officers and Directors of the ISA personally. The officers and committees will report.

"Instrumentation Flow Plan Symbols," by David E. Hostedler (Foster-Wheeler Corp., New York). Paper No. 49-1-1.

Abstract. Paper is intended to introduce an open technical session on symbols for industrial instrumentation; in particular those suitable for depicting such equipment on process flow diagrams. It is based mainly upon Report RP-5.1 of the Recommended Practices Sub-Committee RP-5, of which the author is chairman. It outlines the survey that was conducted on this subject, and includes information on the various systems and practices already in use. Discusses the development of the system contained in the report from the data collected, and the problems associated with such an endeavor. Describes the system of the report, how to use it, and any limitations. Covers criticisms received to date, and thoughts on reconciling certain differences of opinion to meet requirements of greatest possible number of instrument symbol users. Invites additional ideas and suggestions.

A.I.P. Scientific Instruments Session. Room 3. Technical Chairman, A. L. Hughes (Washington University, St. Louis).

"The Cyclotron as an Instrument," by W. W. Salisbury (Collins Radio Co., Cedar Rapids, Iowa).

Abstract. The basic theory and engineering requirements of a particle accelerator of cyclotron type is considered. Auxiliary instrumentation including installation of the machine, beam current amplifiers, probe wattmeters, ion gages and automatic stabilizer equipment is discussed in detail.

"Electronic Instrumentation in Particle Counting," by W. C. Elmore (Swarthmore College, Swarthmore, Pa.).

Abstract. A simple arrangement for particle counting involves an electronic detector of radiation, an amplifier that often contains pulse-shaping networks, a circuit element for discriminating against small undesired pulses, and a counting circuit (or scaler) for recording the number of pulses in a given time. This paper considers the nature of the electrical signal obtained from various detectors of radiation, and the part played by pulse shaping in reducing the pile up of pulses and in improving the signal-to-noise ratio when high amplification is required. These considerations are then applied to explain some design features of a high-gain linear pulse amplifier stabilized by feedback. Next an amplifier having a gain of 250 and a rise time of about 0.02 microseconds, designed for use with a photomultiplier-scintillation counter, will be described. The problem of pulse-height discrimination is discussed, together with descriptions of a few circuits used to select pulses whose amplitudes exceed a chosen bias voltage. Finally a description is given of several successful binary and decimal counting circuits.

"Basic Training in Instruments for Graduate Students in Physics," by E. A. Coomes (University of Notre Dame, Notre Dame, Ind.).

Abstract. If the purpose of a program in experimental physics at a university is to afford the graduate student a basic training in the methods and instruments of modern research, three postwar factors must be recognized: (1) Today in the university physics research laboratory, as well as in the industrial laboratory, many circuits and devices formerly set up by students as part of thesis, are now boxed, shelved, and available with operational instruction books for immediate use. This has lost the student valuable training which he should now receive elsewhere. (2) Many expensive and elaborate instruments, such as the recording potentiometer, are now often available in college physics laboratories. Before the war these were rarely found except in industrial laboratories. The graduate student should be allowed to learn the principles of operation and range of possibilities of such instruments. (3) Many equipments, such as the spectroscope, formerly considered setups for special experiments, have now become simply instruments for research of many kinds. The graduate student has a right to instruction in the use of instruments of this type. How to round out the basic training for graduate students in experimental physics in view of these three considerations presents a challenge to traditional methods of instruction.

National Telemetering Forum

The National Telemetering Forum has arranged meetings for Monday and Tuesday mornings and afternoons (September 12 and 13) on some phase of telemetering activity relating to either airborne or ground equipment, design, production or testing, or general theory.

The Forum welcomes the attendance of members of any organization actively engaged in telemetering design, production or test particularly as applicable to rocket instrumentation and similar work. Such attendance being subject to confidential Bumblebee clearance from the Navy Bureau of Ordnance, Miss Quinn.

Monday, Sept. 12—2:30 P.M.

A.S.M.E. Industrial Instruments and Regulators Session. Room 3. Chairman, G. V. Williamson (Union Electric Co. of Missouri, St, Louis, Mo.) Recorder, R. E. Wright (Monsanto Chemical Co., St. Louis, Mo.).

"Theoretical Considerations on the Optimum Adjustment of Regulators."

"The Optimum Adjustment of Regulators."

Both papers by P. Hazebrock and B. L. van der Waerden (N. V. de Bataafsche Petroleum Maatschappij, Holland) to be presented by N. B. Nichols (Taylor Instrument Cos., Rochester, N. Y.).

Abstract. A practical method is proposed for the adjustment of regulators in order to obtain a satisfactory regulation of a process variable which should be kept at a constant value. The regulator is assumed to perform proportional and integral action, derivative action not being taken into consideration for the present. A general criterion for best regulation is proposed. The first paper presents the results of theoretical analysis and practical methods for assigning definite regulator or controller settings in order to obtain optimum results. The second paper presents the theoretical foundation for the results given in the first paper.

Tuesday, Sept. 13—10 A.M.

I.S.A. Maintenance and Operation Session — Instrument Mechanic Training Panel Discussion. Room 4. Panel Chairman, L. C. Laird (Corn Products Refining Company, Argo, Ill.) Panel Members: R. H. Briggs (Dow Chemical Company, Midland, Mich.) J. H. Cuthbert (Carnegie-Illinois Steel Corporation, South Works, Chicago, Ill.) R. Johnson (Industrial Training Institute, Chicago, Ill.) Papers Nos. 49-3-1, 2, 3.

Abstract. Instrument mechanic training programs now in effect will be presented. The advantages and disadvantages will be pointed out. The requirements and qualifications for new employees, details of the training program, employee classifications, requirements for promotion by examination and work variation procedure will be discussed. The panel will discover teaching techniques, instructor qualifications, training facilities, subjects covered, and texts used. This panel should help lay the groundwork for the establishment of an adequate training course for instrument craftsmen. Brief presentation of other programs and discussions from the floor will be encouraged.

I.S.A. Inspection and Gaging Session. Room 2. Technical Chairman, R. L. Geer (Cornell University, Ithaca, N. Y.).

"Fixed Gages," by F. S. Blackall, Jr. (Taft-Pierce Mfg. Co., Woonsocket, R. I.). Paper No. 49-2-1.

"Concepts of Modern Gaging," by L. J. Mahlmeister (Sheffield Corp., Dayton, Ohio). Paper No. 49-2-2.

"Gage Lab Facilities in U. S. A." by R. L. Geer (Cornell University, Ithaca, New York). Paper No. 49-2-3.

A.I.P. Scientific Instrument Session. Room 3. Technical Chairman, V. P. Jacobsmeyer, S.J. (Saint Louis University, St. Louis.).

"The Photographic Plate as an Instrument in Nuclear Research, Autoradiography, and Radiation Monitoring," by J. H. Webb (Eastman Kodak Company, Rochester, N. Y.).

Abstract. As a means of registering the paths of high-energy particles, the photographic plate resembles closely in action the Wilson cloud chamber. However, because of its higher stopping power, continuous sensitivity, and simplicity, it has distinct advantages not possessed by the cloud chamber. The action of a charged particle on a photographic emulsion depends upon the recording of energy loss as the particle passes through the recording medium and this process will be described. Also the range-energy relationship, the stepping power, and grain spacing observed for different types of particles will be discussed. In addition to the registration of individual nuclear events of high energy, the photographic emulsion has in recent years become an important tool in autoradiography. By placing an emulsion in contact with a material containing radioactive elements, the location and distribution of these elements can be determined. By use of radioactive isotopes, the location of tagged chemical compounds can be followed in biological processes. Some examples of this will be shown. The photographic plate is now being used extensively as a health monitoring instrument when radiation hazards are present. Film badges made up with cadmium and lead shields worn by laboratory personnel will record neutron, gamma ray, and electron exposure.

"Methods of Measurement of Very Small Currents," R. K. Swank (Argonne National Laboratory, Chicago, Ill.).

Abstract. Currents down to 10^{-9} amperes may be measured conveniently with galvanometers or the chopper-amplifier instruments now commercially available. However, for currents much smaller than this we must rely chiefly upon electrostatic measuring devices, usually referred to as electrometers or electroscopes. Of these there are three general types: (1) quartz fiber instruments, which measure a charge by the force it exerts on a mechanical system. (2) vacuum tube electrometers in which the charge on one electrode is measured by its influence on the current to another electrode. (3) dynamic condenser electrometers in which an outside force does work on the charge by moving it against its own field, thus generating a-c. power which can be fed into an amplifier of finite input impedance. The most recent forms of each of these three types are described, with emphasis on the dynamic condenser — the most recent and in many respects the most satisfactory. In order to specify an electrometer for measuring current

must choose between two methods: (1) "deflection" method — measurement of the time required to collect a certain charge on the electrometer; (2) measurement of the equilibrium voltage developed across a high-value resistor. The three types of electrometers are examined as to their usefulness in making these two types of measurement. In addition, remarks on measurement of total charge without regard to rate of collection.

"An Electronic Timer for Seismic Research," by J. A. Volk (Institute of Technology, St. Louis University, St. Louis, Mo.).

Abstract. Shows design and application of a tuning-fork-controlled multiple arc light which is utilized in dual fashion both for recording as well as timing. The circuit is so arranged that each fifth or tenth line is intensified, thereby simplifying the counting.

"Cosmic-ray Instrumentation," by R. J. Sard (Washington University, St. Louis.).

Abstract. Cosmic-ray research is being carried out all over the earth's surface at all depths and latitudes accessible to man. In these experiments it is necessary to make use of meteorological and geological instrumentation. The experimental apparatus itself is, however, of the type used in nuclear research, employing Wilson cloud chambers, ionization chambers, Geiger-Mueller tubes, proportional counters, special photographic emulsions, and crystal counters along with the great variety of electronic equipment that goes with them. Some of the techniques used at Washington University in recent years will be described.

Tuesday, Sept. 13—2:30 P.M.

A.S.M.E. Industrial Instruments and Regulators Session. Room 3. Chairman, C. B. Briscoe (Director, Public Utilities, City of St. Louis, St. Louis, Mo.) Recorder, J. O. Steinman (Union Electric Co., St. Louis, Mo.).

"The International Temperature Scale of 1948," by Harold F. Stimson (National Bureau of Standards, Washington, D. C.).

Abstract. An outline of progress in international standardization of the temperature scale is given. The temperature scale which was adopted at the General Conference of the International Committee of Weights and Measures in 1948 is presented in detail, with particular reference to changes from the International Scale previously in force.

"The Attenuation of Oscillatory Pressures in Instrument Lines," by Arthur S. Iberall (National Bureau of Standards, Washington, D. C.).

Abstract. A theoretical investigation has been made of the attenuation and lag of an oscillatory pressure variation applied to one end of a tube, when the other end is connected to a pressure sensitive element. An elementary theory based on incompressible viscous fluid flow is first developed. The elementary solution is then modified to take into account compressibility; finite pressure amplitudes; appreciable fluid acceleration; and finite length of tubing (end corrections). Account is taken of heat transfer into the tube. The complete theory is derived in an appendix. The results are summarized in eight graphs in a form convenient for use in computing the lag and attenuation of a sinusoidal oscillation in a transmission tube.

Wednesday, Sept. 14—10 A.M.

I.S.A. Session on Instrumentation for Production Processes. Room 1. Technical Chairman, Porter Hart (Dow Chemical Company, Freeport, Texas).

"Process Control by Graphic Panel," by David M. Boyd (Universal Oil Products Company, Chicago, Ill.). Paper No. 49-4-1.

Abstract. The art of instrumentation has passed through several stages, from locally-mounted thermometers and pressure gages to large centralized control rooms. The complexities of some modern processes and the large transmission lags have brought about the adoption of the graphic type of control panel using a simplified flow diagram as the control board and miniature control stations located on the diagram at the points they are controlling. Paper describes the construction of such a panel, built for the Rock Island Refinery at Indianapolis, containing all the controls for a complete oil refinery including crude unit, vacuum unit, catalytic cracking unit, fractionation unit, polymerization unit, and liquefied petroleum gas unit.

"New Recording Refractometer," by Ormond Barstow (Dow Chemical Company, Midland, Mich.). Paper No. 49-4-2.

Abstract. Describes a new instrument which records continuously and automatically the refractive index of a stream of liquid passing through it. Optically the refractometer is of the familiar critical angle or Abbé-type. Instead of the customary visual observation of the field, a photoelectrically-actuated system locates and follows the light-dark boundary, and positions a pen accordingly on a clock-driven chart. The instrument is adapted for recording chemical concentrations and for automatic process control.

"Engineered Flow Metering," by M. J. Boho (Hagan Corporation, Pittsburgh, Pa.). Paper No. 49-4-3.

Abstract. Inasmuch as the differential pressure produced by the primary element of an orifice-type flow meter is a function of both line velocity and fluid density, it is necessary to fix density if the chart reading of such meters is to bear a fixed relation to the true rate of flow. In some cases (e.g. the measurement of natural gas flow) the gas pressure and temperature may depart sufficiently from the conditions assumed by the designer to seriously alter this relationship. In such cases, line pressure and temperature is employed in the secondary element to automatically compensate the meter reading for these variations. The solution for this and similar problems has resulted in the development of flow meters incorporating computing mechanisms which carry out the functions of addition, subtraction, multiplication, division, involution, evolution, and integration. Using these mechanisms, flows, pressures, temperatures, densities, etc., can be combined to provide a variety of combinations suitable for the solution of metering problems hitherto not considered practical. The availability of such mechanisms makes possible the generalized approach of setting down the mathematical equations which describe the desired measurement and arranging the apparatus to carry out the desired solution.

I.S.A. Inspection and Gaging Session. Room 2. Technical Chairman, Captain E. R. Polidor (U.S. Army Ordnance Reserve, Washington, D.C.)

"Light Rays Can Be Tools," by A. R. Fultz (Eastman Kodak Co., Rochester, N. Y.). Paper No. 49-5-1.

"Projection Inspection Tooling," by W. DeBoer (Engineers Specialties, Buffalo, N. Y.). Paper No. 49-5-2.

I.S.A. Transportation Instruments Session. Room B. Technical Chairman to be announced later.

"Aviation Instrumentation," by E. R. Gardner (General Electric Company, West Lynn, Mass.) Paper No. 49-7-1

"Intelligence Instruments for Radio Telemetering and Direct Recording," by G. O. Haglund (Fredric Flader, Inc., North Tonawanda, N. Y.) Paper No. 49-7-2.

I.S.A. Session on Instrumentation for Testing. Room 3. Technical Chairman to be announced later.

"Differential Transformer," by W. D. Macgeorge (Automatic Temperature Control Co., Inc., Philadelphia, Pa.). Paper No. 49-8-1.

Abstract. First part of paper covers, with some historical references, the background of the differential transformer, its peculiar advantages as a measuring device, and specific data on the "Atcotran" (trade mark) type of differential transformer. Second part deals with circuits for use with this device, methods of obtaining ratio, algebraic summation, multiplication, etc., from various input signals and a brief summary of available instruments using the differential transformer.

"An Electronic Inverter for the Measurement of Small D-c. Potentials," by William Harrison (Hercules Powder Company, Cumberland, Md.). Paper No. 49-8-2.

"Frequency Response of Instruments," by R. J. W. Koopman (Washington University, St. Louis, Mo.). Paper No. 49-8-3.

Abstract. In evaluating the performance of instruments, their responses to certain types of inputs as functions of time are required. The most widely used types of these inputs are the "step" input and the "steady-state" sinusoidal input. In certain cases one type of input can be supplied in the laboratory better than the other. This paper discusses simple methods for obtaining the response to the "step" input from the "steady state" response. The method is limited to the underdamped cases. However, it is shown that there are some advantages in underdamping. It is also shown that when the response to the "step" input is known, the response to any other input as a function of time can be found.

"A Versatile Pneumatic Instrument," by W. A. Wildhack (National Bureau of Standards, Washington, D. C.). Paper No. 49-8-4.

"A Rolling-Ball Flowmeter for Hazardous and Corrosive Liquids," by P. I. Wood (California Institute of Technology, Pasadena, Calif.). Paper No. 49-8-5.

Abstract. The rolling-ball flowmeter is a unique type of instrument which possesses certain advantages of value in applications involving hazardous or corrosive liquids. In this paper, a brief description of the flowmeter is presented along with experimental results obtained for the instrument used with six liquids, including liquid nitrogen and liquid oxygen.

I.S.A. Maintenance and Operation Session. Room 4. Technical Chairman, F. H. Theile (Tennessee Eastman Corp., Kingsport, Tenn.).

"Instrument Shop Layouts," by R. L. Nichols (Magnolia Petroleum Company, Beaumont, Texas) Paper No. 49-6-1.

Abstract. To assist in setting up modern, efficient Instrument Shops, complete floor plans and adequate shop layouts are illustrated and discussed. Installations of automatic control equipment have, in many plants, proceeded at a much faster pace than provision of facilities for maintenance and servicing. In other plants, lack of knowledge as to the requirements of this craft have resulted in poorly designed shops. Instrument shop layouts in several plants are described, and suggested "ideal" shop layouts for various size plants are included.

"Instrument Shop Testing Equipment," by H. U. Fisher (Monsanto Chemical Company, Monsanto, Ill.) Paper No. 49-6-2.

Abstract. Instrument Shop testing equipment—calibrating standards, calibrating baths and furnaces, etc.—required in an up-to-date shop are described. The Instrument Shop must have testing equipment to fit its individual needs. The continuous processing plant, exemplified by a petroleum refinery, will require different testing equipment than that required in a steel mill. Batch type operation sometimes requires still a different type of testing equipment. These differences are pointed out. The value of testing apparatus in an Instrument Shop depends upon the manner in which it is used. Applications showing typical arrangements will be presented. The value of convenience of setup in using test apparatus is also discussed.

"Instrument Shop Tools," by F. S. Becker (Sun Oil Company, Marcus Hook, Pa.) Paper No. 49-6-3

Abstract. Shop tools required in various sized Instrument Shops—the ideal setups—are described. Machine tools, welding equipment, soldering equipment, washing and cleaning devices, general purpose tools, special tools, etc., required in a modern instrument department are discussed. This paper will be an aid to both those planning to equip a new Instrument Shop and to those wanting to improve the effectiveness of their present shop.

Wednesday, Sept. 14—2:30 P.M.

A.S.M.E. Industrial Instruments and Regulators Session. Room 3. Chairman, J. C. Parmely (Midwest Piping & Supply Co., St. Louis, Mo.) Recorder, Herbert Kuenzel (Washington University, St. Louis, Mo.).

"Control Systems for Distillation Towers," by C. Pyle (E. I. du Pont de Nemours & Co., Wilmington, Del.).

Abstract. Generally, distillation tower control systems are described. An elementary analysis is made of the behavior of the tower as a fractionating device and the effect of various control systems on fractionating capacity. It is shown that the variables placed under control are selected because they provide good indices of the physical operation of the tower itself.

"Practical Approximations for Summarizing Square Function Measurements of Two Flows," by D. T. Gunderson (Askania Regulator Co., Chicago.)

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Abstract. Very careful analysis is sometimes required to properly evaluate the usefulness of an approximate solution. Two simple flow summarizing problems are discussed to show, by comparison with an ideal solution that, in general, an approximate solution will be physically less complicated, initially less expensive and can yield useful results within limitations; the approximate solution may be less easy to understand or to adjust because controlled variables are less completely separated; in general, the process must be better understood to apply an approximation; higher caliber judgment may also be required to obtain optimum results.

Thursday, Sept. 15—10 A.M.

I.S.A. Session on Instrumentation for Testing. Rocket and Jet Symposium. Room 2. Technical Chairman, W. A. Wildhack, (National Bureau of Standards, Washington, D. C.).

"A Central Recording System," by C. G. Hylkema, (California Institute of Technology, Pasadena, Calif.). Paper No. 49-10-1.

Abstract. A central recording system is one in which the data from experiments proceeding in widely dispersed areas throughout a laboratory are recorded in one central location. The recording center contains all the recording, intermediate, and control equipment. The intermediate equipment and the recorders can be conveniently combined into any desired system by means of patch cords. Lead-sheathed cable completes the circuitry between the recording center and the test locations. The system has been operating successfully for the instrumentation of rocket-motor tests.

"Gages for the Measurement of Rocket Thrust," by Harry Stern and William Harrison (Hercules Powder Company, Cumberland, Md.). Paper No. 49-10-2.

"Adaptation of Industrial Instrumentation to Static Testing of Liquid-Propellant Rockets," by W. F. Abbott (U. S. Naval Air Missile Test Center, Point Mugu, Calif.). Paper No. 49-10-3.

Abstract. Although certain phases of liquid propellant rocket research, development and testing have necessitated the development of special instrumentation, many problems can and are being solved by correct application of conventional industrial instruments and apparatus to liquid propellant rocket static testing. Review of static test procedures, critical test conditions, and rocket performance parameters. Survey of typical industrial instrumentation which can be satisfactorily used in rocket test installations. Summary of measurement and control problems of rocket testing. Discussion of application of mechanical instrumentation to measurement and control of rocket powerplant performance with reference to instrument response rate, accuracy, and flexibility. Improvement of these characteristics by adaptation, modification and adjustment of instruments is discussed. Review of electrical and electronic measurement and control systems; characteristics and applications; adaptation and modification procedures. Brief evaluation of electrical versus mechanical instrumentation with reference to specific test requirements. Present instrumentation practices are discussed with reference to advancement in industrial instrument design, anticipated requirements, and potentialities of industrial instrumentation for specialized testing applications.

"Measuring the Reaction Time of Explosives," by James C. Coe (U. S. Naval Air Missile Test Center, Point Mugu, Calif.). Paper No. 49-10-4.

Abstract. The effective use of explosives in civilian and military applications requires accurate timing. In mining operations where several charges are fired together, it is important that the time lapse between charges be kept down in order to be most effective. In military ordnance the time lapse between aiming and firing must obviously be short. Time measurements in blasting caps and electric detonators present a convenient method of quality control in order to prevent the reaction from being too slow, or in the other extreme too sensitive from the standpoint of safety in the presence of static electricity. The time required after the application of current to a blasting cap or electric detonator for the flame to reach a specified point is covered in detail. By means of a slight modification the time interval between the application of a current to a relay, circuit breaker, etc., and the travel to a predetermined point can be accurately measured. Also the time of travel between two points can be determined. The measurements covered vary from a fraction of a microsecond to 100 milliseconds, with two sets of equipment. Since explosive measurements of this nature presented novel problems and produced some hitherto unknown results, they will be covered more fully than the measurement of mechanical travel.

"Rocket Applications of Electrostatic Generating Voltmeters," by John F. Clark, Jr. (Naval Research Laboratory, Washington, D. C.). Paper No. 49-10-5.

Abstract. Since 1947, the NRL has installed electrostatic generating voltmeters in six of the upper-atmosphere research rockets which have been fired at the White Sands Proving Ground (five V-2's and one Aerobee). These instruments utilized rotating shutters to modulate and thus measure the intensity of the component of the electrostatic field normal to the rocket surface. It was determined that the field due to an electric charge on the rocket could be separated from that due to existing potential gradients above the earth by a suitable distribution of generating voltmeters over the rocket skin. Instruments developed are suitable for use under the severe conditions of vibration, acceleration, and temperature variation which exists in rockets. The latest model measures electrostatic field intensities of 1 to 10,000 volts per meter, in two simultaneous ranges. By utilizing the output voltages of the two channels, continuous records of the amplitude and polarity of the electrostatic field have been obtained. Amplitude changes were following accurately within 0.1 second.

I.S.A. Session on Instrumentation for Production Processes. Room 1. Technical Chairman, W. E. Boyle (Shell Oil Company, Wood River, Ill.).

"Dynamic Accuracy in Temperature Measurement," by N. B. Nichols and J. G. Ziegler (Taylor Instrument Companies, Rochester, N. Y.). Paper 49-9-1.

Abstract. The dynamic accuracy of a temperature measuring element has become more and more important as industrial processing changes from large batch type operations to smaller continuous processes. The dynamic accuracy of an indicating or recording system of temperature measurement is determined by the thermal properties of the measuring element and the mechanical properties of the recording or indicating system. We will show that it is possible to increase the dynamic accuracy by the use of a derivative compensating circuit. This derivative compensation is especially valuable in those applications where the thermal mass and thermal resistances are dictated by application requirements of mechanical strength and corrosion resistance.

"Effect of Control Point Location on Column Control," by K. D. Uitti (Universal Oil Products Company, Chicago, Ill.). Paper 49-9-2.

Abstract. This work was done with the hope of providing more fundamental thought on the nature of the effect of the variables in fractionation. Much of the work written on fractionator control has had its basis in dogmatic statements with no proof other than what appears to be "common sense" assertion, and often one finds completely erroneous statements, which possibly would not have been made if care were taken to arrive at conclusions by a series of calculations of the nature to be presented here. A classic misstatement is that the temperature control point should be located in the column where the greatest change of temperature from deck to deck takes place. It is hoped that the work presented here will help to point out rigorous methods for making column control generalization. The specific types of questions as these are amenable to such treatment.

I.S.A. Session on Analysis Instrumentation. Room 4. Technical Chairman Elden D. Haller (National Technical Laboratories, Bethesda 14, Md.).

"The Isotope Ratio Mass Spectrometer," by C. E. Berry, G. W. McDaniel and R. L. Sink (Consolidated Engineering Corp., Pasadena, Calif.) Paper No. 49-11-1.

"Moving-Coil Recording Galvanometers," by H. E. Burke, Jr. (Consolidated Engineering Corp., Pasadena, Calif.) Paper No. 49-11-2.

Abstract. Outstanding application of moving-coil recording galvanometers is that of synchronizing many records so time sequences can be studied. Many galvanometers can record on the same paper, which gives automatic synchronization; and records can be synchronized together with time reference traces, in such a way that literally hundreds of recordings can easily and accurately be studied in time relationship to each other. This paper discusses both the theoretical and practical aspects which determine the galvanometer's recording characteristics. Applicable solutions of the basic vibration differential equation are elaborated into the relations[hip] of sensitivity, frequency range, and damp[ing]. Certain design characteristics that may result [in] unnecessary limitations or special advantag[es] are discussed, and the recorded spurious r[esponses] explained. The equivalent electrical [analogy] with this mechanical system is describe[d] resultant implications in certain spec[ial] electronic circuits. Paper concludes with a discu[ssion of] recorded responses of a galvanomet[er to] fronts of short duration.

"Memory Controlled Serv[o] Mec[hanisms in a Recording Infrared Spectr[o]photometer," by R. Glen Mads[en, M.] Stickney, R. C. Hawes and A. O. Bec[kman] (National Technical Labo[ratories], South Pasadena, Calif.). Paper N[o.] 49-11-3.

Abstract. An automatic control system is described which enables a single-beam infrared spectrophotometer to record absorption spectra directly in transmittancy with a linear wavelength presentation. A standardizing run through the desired wavelength region is made with an empty gas cell or a solvent-filled liquid cell in the optical path, while the slit width is automatically controlled to maintain constant energy at the photoreceiver. Slit-width position as a function of wavelength to maintain a constant 100% reference level is recorded on a wire recorder by circuits described in detail. The sample is introduced into the optical path and the wavelength and slit servos are controlled by the wire recorder to reproduce the standardizing conditions; thus absorption of the sample as a function of wavelength, recorded on a Brown strip-chart recorder is referred to the previously memorized 100% reference level, giving a direct transmittancy record. Chart motion linear with wavelength to the desired accuracy is achieved by the use of a novel electromechanical cam which corrects for the non-linear dispersion inherent in prism spectrophotometers. An accuracy of 5 millimicrons is readily obtained with a reproducibility of better than 1 millimicron, or one part in 13000.

Thursday, Sept. 15—2:30 P.M.

A.I.E.E. Electronic Instruments Session. Room 3. Technical Chairman, J. G. Reid, Jr. (National Bureau of Standards, Washington, D. C.).

"A Wide-band D-c. Amplifier Stabilized for Gain and for Zero," by A. J. Williams, Jr., W. G. Amey, and W. McAdam (Leeds & Northrup Company, Philadelphia, Pa.).

Abstract. Previous technical literature has described direct-coupled d-c. amplifiers having a wide frequency pass band but with appreciable zero drift, and also has described contact-modulated d-c. amplifiers having a relatively stable zero but with a narrow pass band. Paper describes an arrangement of a direct-coupled amplifier together with a contact-modulated amplifier which arrangement retains the wide band of the former and the zero stability of the latter. Block diagrams are used for explanation, and schematic circuits are given for an experimental set-up. Records from a cathode-ray oscillograph and from a fast direct-writing recorder discloses the results achieved, such as (1) rapid response to a step input, and (2) great reduction in the effect resulting from large, unbalanced changes of heater voltage.

"A Regulated Adjustable Low-voltage D-c. Supply for Electrolysis and Other Use," by M. L. Greenough and W. E. Williams, Jr. (National Bureau of Standards, Washington, D. C.).

Abstract. Describes an electronic power source for use in selective electrolysis or as a low-voltage regulated supply. Its output is d. c. continuously controllable from zero to five volts at two amperes. Among its features are ripple content of 0.1 %, and an output resistance of 0.01 ohm. The input impedance of the regulator circuit itself is in the order of 10 megohms, permitting control from high-resistance electrodes. The instrument uses a variable-amplitude 2-kc. carrier which is amplified by a power stage and fed to a dry-disk rectifier. The output is then automatically controlled for equality to a self-contained adjustable reference voltage. With modifications in the high level stages, the circuit is adaptable to a wide range of output capacities.

"Radiosonde Instrumentation," by Walter R. Beam (University of Maryland, College Park, Maryland).

Abstract. A radiosonde is any telemeter employed in the transmission of atmospheric data from the upper air to ground or airborne receiving stations. Since the beginning of World War II, extensive research, development, and manufacture has taken place in this field, both in this country and abroad. Four of the best systems by which data are obtained and transmitted are explained in detail, and illustrations

several radiosondes are shown. A brief comparison of these systems, as regards practicality, accuracy, and economy, is made. Of particular interest are some of the instruments developed since the War, including a radiosonde capable of transmitting International Morse Code symbols, and pressure instruments enabling flights to 150,000 feet. Rocket-carried instruments, of somewhat different design from those carried by balloon or parachute, are interesting because of the physical and electrical requirements. Inasmuch as weight is a primary consideration in any air-supported machine, it is pointed out how lightness of weight may be achieved without sacrifice in accuracy.

"Velocity and Flow Measurements with an Improved Thermal Instrument," by C. E. Hastings (Hastings Instrument Company, Hampton, Va.).

Abstract. An improved thermal anemometer with unusual sensitivity and higher accuracy than heretofore obtainable at the lower velocities has been achieved by placing a heated thermopile in an air stream whose velocity is to be measured. The flow of air past the thermopile tends to bring the thermopile wire, consisting of a succession of thermojunctions, to the same temperature throughout. The thermal difference between these junctions induce a thermal voltage proportional to the temperature differences. Thus, flow of air past the thermopile tends to reduce this temperature difference and therefore, to reduce the d-c. voltage generated by the thermopile. Extreme sensitivity leads to difficulties in establishing accurate calibration methods in low-velocity ranges. Calibration methods are discussed. Errors due to change in air temperature are compensated since both cold and hot junctions are equally affected. Likewise, radiation effects tend to cancel. New unit is well adapted to remote recording on standard types of indicating or recording instruments (potentiometers, etc.) which operate from d-c. voltage. By incorporating this thermopile element in a pipe or duct, the d-c. voltage output can be calibrated to indicate or record a rate of flow of air or gas through the pipe.

Friday, Sept. 16—10 A.M.

I.S.A. Session on Instrumentation for Production Processes. Room 1. Technical Chairman, R. D. Webb (Carbide and Carbon Chemicals Corp., South Charleston, W. Va.).

"Cutting the Cost of Control," by L. E. Oberhelman (Standard Oil Company (Ind.), Sugar Creek, Mo.). Paper No. 49-13-1.

Abstract. There has been rapid development during the last twenty years in industrial instruments and process control. In refineries and chemical plants, there has been continual improvement in the application of instruments, but little has been done towards the reduction of installed cost and operating costs. Such costs may be reduced in many cases by the application of new type instruments and controllers, and redesign of process control circuits, where possible. Construction costs of old and new types of instruments are evaluated. Maintenance and operating costs are also discussed. Limitations of the new equipment are also brought out, to give an unbiased appraisal of the methods discussed in the examples.

"Industrial Radar for Hurricane Tracking," by W. F. Gerdes and R. C. Jorgensen (Dow Chemical Company, Freeport, Texas). Paper No. 49-13-2.

Abstract. This is an account of the program which The Dow Chemical Company undertook in operation with the U. S. Weather Bureau in an effort to obtain adequate and reliable warning and continuous tracking of the approach of tropical hurricanes. Background and reasons for the program are given. A layman's description of a hurricane is included; also brief outline of radar principles helpful in understanding the work. Radar equipment is described in some detail, including modifications required for weather work. Observation methods and results of the first year's work are given. An evaluation of the program from the practical viewpoint of Dow's management indicates that the work has been very successful and quite essential to the company's operations on the Gulf Coast.

I.S.A. Session on Instrumentation for Testing. Room 2. Technical Chairman, W. G. Brombacher, (National Bureau of Standards, Washington, D. C.).

"The Development and Maintenance of Calibrating Standards by An Instrument Manufacturer," by W. D. Wood (Standards Laboratory, Taylor Instrument Companies, Rochester, N. Y.). Paper No. 49-14-1.

Abstract. Paper deals with the practices followed by a manufacturer of temperature, pressure, and flow instruments in developing and maintaining calibrating standards. It covers the principles involved in selecting factory working standards and laboratory reference standards. The achievement of accuracy in standards is discussed and a system of records is described. Examples are given of custom-built standards for specific applications.

"Unique Instrumentation for Ordnance Testing," by Ralph Hightower (Naval Ordnance Laboratory, White Oak, Md.). Paper No. 49-14-2.

Abstract. To determine the adequacy of underwater weapons prior to their use by the fleet requires instrumentation from subminiature to gigantic in size. The prime requisite of any instrumentation set-up is to determine some basic factor of weapon operation under near service use. A simple accelerometer capable of measuring peak accelerations in the range from 50 to 2000 *g* is discussed. Larger instrumentation, such as underwater weapon recovery system and magnetic simulated equipment installed in a water test area, are also outlined. Knowing the position of underwater weapons is often a most important feature when related to time. One scheme for determining the position of depth-charge type weapons is outlined.

"Radio Link Telemetering during High Accelerations," by Sidney Himmelstein (Naval Ordnance Laboratory, White Oak, Md.). Paper No. 49-14-3.

Abstract. Radio link telemetering that will work during accelerations of the order of a thousand times gravity require special considerations. Limits of conventional circuits are discussed and conclusions are drawn on the nature of shock-resisting circuits. A subminiature pulsed transmitter capable of working during high accelerations is described. One-microsecond pulses, either amplitude- or frequency-modulated, are employed. Work done is in the region from 30 to 100 Mc. Details of the associated ground equipment are given. Theoretical and practical considerations of the system are included.

"An Economical Circuit for Square-wave Keying of Oscillators," by J. Carl Seddon (Naval Research Laboratory, Washington, D. C.). Paper No. 49-14-4.

Abstract. High peak power oscillators of low duty cycle present a difficult modulating problem if the pulse width is wide or extremely variable. A low-power circuit is illustrated which makes possible square-wave grid modulation of oscillators over a wide range of pulse widths and duty cycle. 15 watts average power will control an oscillator capable of giving 7.5 kilowatts peak power output. Pulse widths from 2 to 140,000 microseconds have been used, and this range can easily be extended. The circuit is also useful for obtaining high-voltage video pulses, either negative or positive.

"Long-Range Multi-channel Telemetering System," by John T. Mengel (Naval Research Laboratory, Washington, D. C.). Paper No. 49-14-5.

Abstract. A 30-channel pulse-time-modulation telemetering system for ranges in excess of 500 miles with an individual channel sampling rate of 312.5 samples per second has been developed and utilized by the Naval Research Laboratory for recording data originating in many of the large rockets fired at the White Sands Proving Ground. The system operates on an "L" band r-f. carrier of between 950 and 1050 Mc/s. utilizes its own storage battery power supply suitable for 30 minutes of operation, has a peak output pulse power of about 4 kw, measures 30 separate input voltages varying between 0 and +5 volts, an overall accuracy of ±1%, and has a total installed weight, less r-f. feed cable, of about 130 lbs. Design and operational data of both the missile-borne transmitter and the ground receiver-recorder stations are given, with a comparison between this system and previous pulse-time-modulation telemetering systems made.

"Fundamental Engineering of Bourdon Tube Pressure Indicating Gages," by E. H. Grauel (American Chain and Cable Company, Inc., Bridgeport, Conn.) Paper No. 49-14-6.

Abstract. Discusses important points of Bourdon tube engineering for which mathematics have been found impractical. Emphasis has been placed upon the impossibility of calibrating Bourdon tube gages to ±0.00% error with linear dials. The instructions under "Calibration" should prove valuable to instrument men who wish to save time when recalibrating.

I.S.A. Session on Analysis Instrumentation. Room 4. Technical Chairman to be announced later.

"Logarithms in Instrumentation," by W. G. James (Oak Ridge National Laboratory, Oak Ridge, Tenn.). Paper No. 49-15-2.

Abstract. Survey of applications of instruments whose outputs are proportional to the logarithm of their inputs, and of the devices available for obtaining such response in instruments. Instruments developed and used at Oak Ridge National Laboratory are included as well as those described in the technical journals. The devices described have been used to measure logarithmically currents from 0.03 micromicroampere to ten milliamperes and voltage from one millivolt to ten volts. The only practical limit in the preceding is the 0.03-micromicroampere value. The large number of methods available for making currents or voltages proportional to other quantities permits a great number of measurements to be made with these logarithmic devices.

"A Simple Low-drift Electrometer," by F. M. Glass (Oak Ridge National Laboratory, Oak Ridge, Tenn.). Paper No. 49-15-3.

Abstract. Increased demand for means of measuring very small currents and potentials has brought about the development of many electronic instruments for this purpose. Some of these instruments are no more than simple vacuum-tube voltmeters designed around the recently-developed electrometer tubes. Paper discusses design principles and construction details for one model of this type, featuring a-c. operation, compactness, low drift, moderate sensitivity, ruggedness, and low cost.

Friday, Sept. 16—2:30 P.M.

A.I.E.E. Electrical Instruments and Measurements Session. Room 3. Technical Chairman, J. P. Scott (Union Electric Co., St. Louis).

"A New Thermal Converter for Telemetering and Totalizing," by Wm. C. Downing, Jr. (Sangamo Electric Co., Springfield, Illinois).

Abstract. Thermal converters, used as primary elements in the telemetering and totalizing of large power loads, generate direct voltage accurately proportional to the a-c. power measured. The difference of power input to two heaters of a pair is made proportional to the measured power by a modification of the conventional thermal wattmeter circuit; and the resultant temperature difference is measured by thermocouples. A new thermal converter is described in which the thermocouple junctions are in direct contact with heaters, each of which is energized from a conductively isolated circuit; and the problems of electrical circuits and heat flow relations are discussed from the design point of view.

"A New Expanded-scale A-c. Voltmeter," by N. P. Millar (General Electric Company, West Lynn, Mass.).

Abstract. The successful application of a saturating core reactor to a standard electrodynamic wattmeter mechanism has resulted in a new design of an expanded-scale voltmeter with improved reliability and an accuracy of ½ percent of full scale rating. One half-volt variations can be detected and read easily in the expanded region from 90 to 130 volts where 130 volts represents full scale or 250 degrees of scale arc. Approximately 220 degrees of that scale are are utilized in expansion from 90 to 130 volts. Frequency error is compensated to within ¼ percent of full scale per cycle over a 55 to 65 cycle range. The device is self contained and requires no auxiliary means for operation. A natural zero has been maintained, and a fast-responding moving system makes this voltmeter very sensitive to small and rapid voltage fluctuations.

"Electrical Measuring Instruments, Developments and Standardization," by D. A. Young (Westinghouse Electric Corp., Newark, N. J.).

"V-2 Rocket Instrumentation," by George J. Fiedler (Sverdrup & Parcel Inc., Consulting Engineers, St. Louis, Mo.).

Abstract. Inasmuch as the guided missile is an expensive, expendable aircraft, much effort is devoted to the complete instrumentation of the test firing program. Systematic firings of captured German V-2 rockets at White Sands Proving Ground have given a "free ride" to American instrumentation, and have permitted the development and test of missile instrumentation to progress, pending the production of American missiles. Special problems arising in the instrumentation of full-scale free-flight tests of guided missiles are considered. Within the limits of security regulations, the application of optical, radar, radio-doppler, telemetering and computing equipments to the flight testing of V-2 missiles is discussed.

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DESCRIPTIVE LIST *of the* EXHIBITS *and* PERSONNEL *in* ATTENDANCE

AB Enkopings Verkstader, Enkoping, Sweden 133
Exhibiting: Dust particle centrifuge for analysis of grain size.
In Attendance: Henrik Manden.

Aircraft-Marine Products, Harrisburg, Pa. 211
Exhibiting: New solderless terminals and connectors for electrical wiring applied by automatic machines, hand tools, airguns, etc. Solderless terminals and connectors of all kinds for electrical wiring.
In Attendance: Edward A. W. Smith, Herbert Nolan, Robert McKay, John Pierce, John Case.

Alfax Paper & Engineering Co., Brockton, Mass. 115
Exhibiting: Electrosensitive paper for recording instantly without ink and without delay; "Helix" type inertialess recorders giving writing speeds of 300 inches per second and up.
In Attendance: S. C. Sviokla.

American Institute of Electrical Engineers, New York, N. Y.....602
Exhibiting: Publication, data on the A.I.E.E.
In Attendance: J. S. Lopes, Ad. Mgr., Electrical Engineering; R. C. Horn, Chairman, St. Louis Section; J. P. Scott, Chairman, A.I.E.E. Committee for Instrument Conference and Exhibit.

American Institute of Physics, New York, N. Y.....139
Exhibiting: "Review of Scientific Instruments"; "Journal of Applied Physics"; "Physics Today."

American Meter Co., Philadelphia, Pa. 732, 734, 736
Exhibiting: New Pneumatic Flow Transmitter; new Recording Controller Receiver. Recording flowmeter, indicating flowmeter; integrating orifice meter; wet test meter; dry test meter; pressure regulator; orifice fittings; high and low pressure positive displacement meter; miniature control valves; laboratory apparatus.
In Attendance: W. G. Hamilton, V. P. Sales; A. F. Benson, V. P. Prod. & Res.; A. S. Chatfield, A. B. Cloud, A. Costa, L. Hickman, D. J. Harty, R. Wilmarth, J. Pruit, B. McKalip, Sales Engineers; R. Gray, W. Kehoe, Research Engrs.

Anders Company, New York, N. Y.....116
Exhibiting: New Desomatic Air Dryer, a portable space dehumidifier up to 6000 cu. ft. Anders instrument air dryer.
In Attendance: E. W. Anders, Owner; F. M. Bartlett, J. F. Smith, Tulsa Representatives; S. S. Williams, Houston Representative.

Annin Co., Los Angeles, Calif.....231
Exhibiting: New Domotor valves a radical new design in fluid control valves, reduces weight over fifty percent, produced in hard to cast alloys. New Motor Operator provides 5 to 10 times operating power of conventional designs. Check valves, manual valves, electro-pneumatic valves. Alloy valves for errosive and corrosive services at high temperatures 1000°F. to low temperatures —298°F.
In Attendance: D. H. Annin, Mgr.; Joe Huber, St. Louis Rep.; Paul A. Condit, Houston Rep.

Applied Physics Laboratory, John Hopkins University, Silver Spring, Md.....226
Exhibiting: A Telemetering System, FM/PM ten band airborne telemetering and associated ground station and calibration equipment; telemetering components; research to Navy Bureau of Ordnance.
In Attendance: W. J. Thomas, Telemetering Engr.

Applied Research Laboratories, Glendale, Calif. 112
Exhibiting: Applied Research Laboratories spectro-chemical equipment, new model of 1.5 Meter Spectrograph. Complete line of Spectro-chemical equipment.
In Attendance: W. E. Davis, General Sales Manager; Alan Goldblatt; Bernard Boyd, Robert F. Feland, Sales Engineers.

Associated Research, Inc., Chicago, Ill. 239
Exhibiting: Vibrotest; Vibroground; Hypot; Phase Sequence Indicator; Donut transformers. Manufacturers, designers, research and development.
In Attendance: James F. Inman, Pres.; Ray Holmes, V. P. & Gen. Mgr.; R. G. Davis.

Automatic Temperature Control Co., Philadelphia, Pa. 606
Exhibiting: New Atcotran pressure differential pick-up devices. Vernier Set timer; standard line of electric and electronic timers.
In Attendance: W. W. Winters, Sales Mgr.; G. J. Ebling, Sales Pro. Mgr.

Automatic Electric Co., Chicago, Ill. 709
Exhibiting: New telephone type relays and switches for industrial control purposes; hermetic enclosure of relays. Automatic telephone switchboards, accessories and components. Manufacturer and installer.
In Attendance: V. E. James, Mgr. Ind. Control Equip. Sales; K. A. Regal, Mgr. Specialty Sales; M. G. Gnau, Salesman.

Bailey Meter Co., Cleveland, Ohio 729, 731
Exhibiting: New adjustable characteristic valve positioner; new totally enclosed control drive; new smoke density recorder. Meters and controls for power plants and industrial processes. Application engineering.
In Attendance: H. M. Hammond, V. P.; P. S. Dickey, V. P.; N. M. Barnett, Mgr. Chicago office; C. E. Albert, Mgr. Kansas City office; R. M. Cundiff, Mgr. Cincinnati office; C. H. Barnard, Application Engrg.; V. S. Rutherford, Eng. of Elect. Insts.; E. B. Bossart, Adv. Mgr.

Baird Associates, Inc., Cambridge, Mass. 708
Exhibiting: Infrared recording spectrophotometer; infrared gas analyzer; direct reading spectrometer; grating spectrograph.
In Attendance: S. H. Walters, Sales Mgr.; P. C. Hutchinson, J. M. Devine, R. P. Mahan, H. A. Hickey, Sales Engrgs.

Barbour Stockwell Co., Cambridge, Mass. 322
Exhibiting: New Reliance Hourmaster converts R.P.M. into hours of operation; Reliance Millemaster converts R.P.M. into Miles Reliance tachometers, adapters, flexible shafts, clutches, gear boxes, instrument panels.
In Attendance: John J. Whitehouse, Mgr., Instrument Div.

Barton Instrument Co., Los Angeles, Calif. 235
Exhibiting: Model 163 and Model 200 differential pressure indicators and Model 202 differential pressure recorders.
In Attendance: Joseph Huber, St. Louis Rep.

Arnold O. Beckman, Incorporated, Pasadena, Calif. 515
Exhibiting: New Model G-2 Recording Oxygen Analyzer, high precision, panel mounted null type oxygen recorder or recorder controller for measurement of oxygen in industrial applications; new Picket Dosimeter, quartz fiber electroscope gamma radiation detector for personnel monitoring; new Charger for use in charging the Pocket Dosimeter. Model C Oxygen analyzer for laboratory use; Model D Oxygen analyzer for use in hospitals; Model E-2 Oxygen Analyzer, for determination of oxygen percentages in laboratory or industrial applications; Model F-2 indicating Type Oxygen Analyzer similar to the Model G-2 less the recorder.
In Attendance: Dr. A. O. Beckman, President; G. W. Weaver, General Manager.

James G. Biddle Co., Philadelphia, Pa. 20
Exhibiting: New Dual-Operated Meg type of Megger Insulation Tester. Megger insulation testers, Megger ground testers, low resistance ohmmeters, TTR transformer ratio test set, Jagabi speed measuring insts., Frahm resonant reed tachometers and frequency meters.
In Attendance: A. Q. Lange, Sales Engr.; Stuart Sommer, Adv. Mgr.

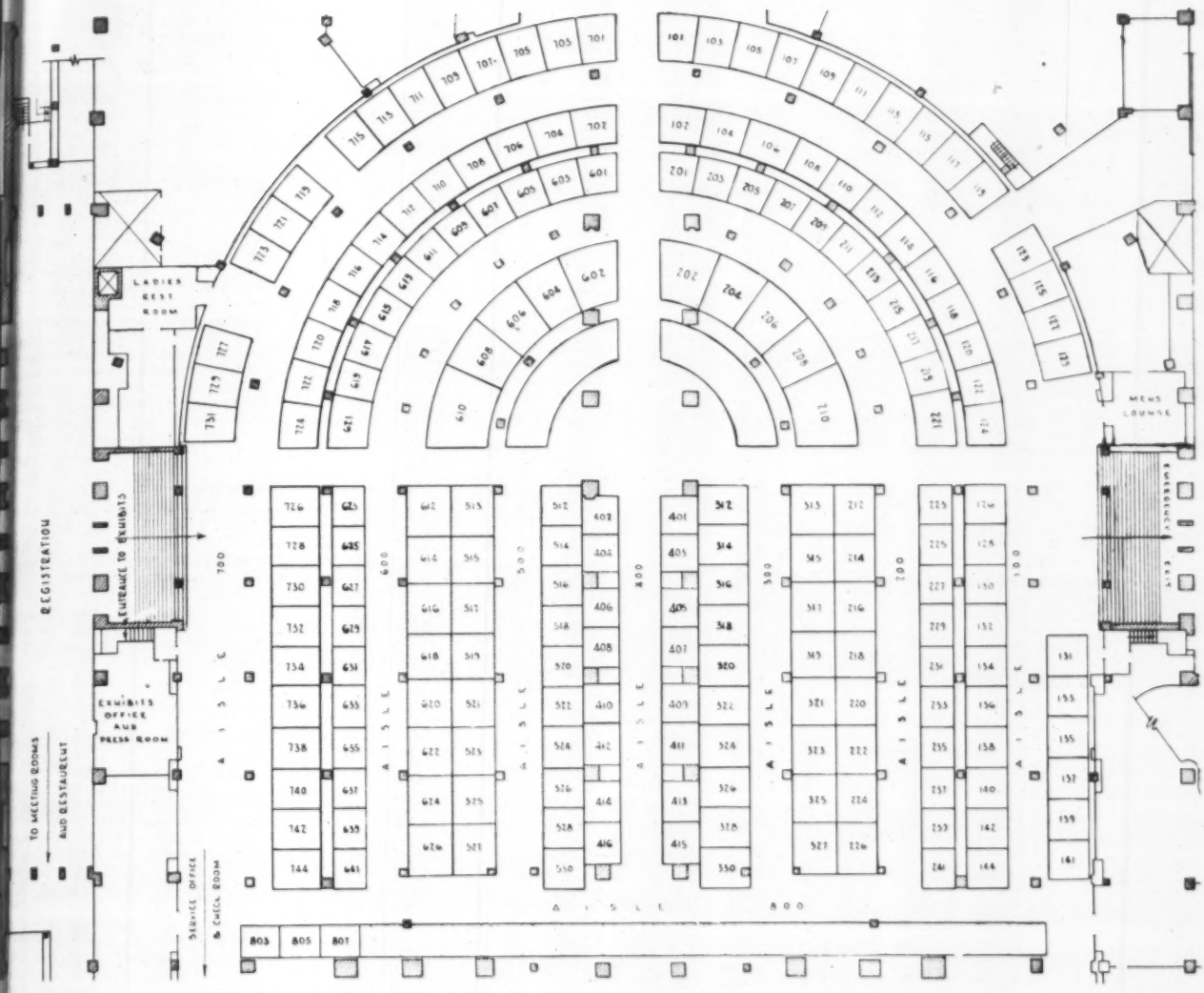
J. Bishop and Company Platinum Works, Malvern, Pa. 61
Exhibiting: Stainless steel capillary tubing, stainless steel pressure tubing; stainless steel tubular specialities and fabricated parts.
In Attendance: P. C. Kerk, Pres.; E. E. Comfort, Prod. Mgr.; G. M. Hickey, Sales.

The Book Shop Bindery, Chicago, Ill. 117
Exhibiting: A new concept in the binding of scientific, technical and reference journals.
In Attendance: Mary Lou Callius, Library Asst., J. Herpe, Sales.

The Bristol Co., Waterbury, Conn. 312, 314, 316
Exhibiting: New Series 500 instruments including air-operated controls; wide strip pH recorders and controllers; Dynamaster resistance thermometer; Pyrovisor radiation pyrometer; absolute pressure recorder; recording voltmeters and ammeters; telemetering instruments over wires and Micro Wave for pressure, temperature, flow, motion, liquid level, power and other electric quantities; running-time and running-count production recorders; wide-strip recorders; thermoverter for totalizing electrical power; pneumatic transmission instruments; Electronic Pyrotol combustion safeguards for ovens, furnaces and heaters; diesel engine pyrometers; unit instrument panels; operating models for instruments for furnaces, ovens, kilns, metal working. Model 93 air-operated controllers; recording thermometers; recording gauges; recording flowmeters; electric-type controllers; thermocouples and pyrometer accessories.
In Attendance: H. H. Bristol, Pres.; W. H. Faeth, Ex. V. P. & Treas.; H. E. Beane, Gen. Sales Mgr.; F. W. Borchers, Asst. Sales Mgr.; A. A. Blackman, St. Louis Dist. Mgr.; D. C. Safford, H. R. Bristol, M. D. Shriver, Application Engineering Dept.; E. Nuber, Mgr. Application Engrg. Dept.; G. P. Lonergan, Mgr. Sales Promotion Dept.

Brookfield Engineering Laboratories, Incorporated, Stoughton, Mass. 21
Exhibiting: New Viscosyn, automatic viscosity recorder. Viscotrol and Synchro-lectric Viscometer, Viscometric Engineering.
In Attendance: D. W. Brookfield, Director of Research; G. W. Brookfield, Treasurer; W. B. Brookfield, President.

Brooks Rotameter Company, Lansdale, Pa. 712, 71
Exhibiting: New Inductronic Flow Alarm; High Pressure rotameter; Brooks-Mite Purge Rotameter; Triple Meter, Multi-Flow Laboratory Kit. Full line of our regular rotameters including the Full-View rotameter, Inductronic Remote Recorder.
In Attendance: S. A. Brooks, President; D. N. Brooks, District Sales Manager; J. S. Derham, Applications Engineer; E. E. Nyce, Instrument Engineer.



FOURTH ANNUAL INSTRUMENT EXHIBIT

Municipal Auditorium, St. Louis, Mo., Sept. 12-16, 1949

EXHIBIT HOURS: Mon., Tues. & Thurs., 12 noon to 10 p.m.; Wed. & Fri., 10 a.m. to 3 p.m.

Brush Development Co., Cleveland, Ohio 738

Exhibiting: New six channel direct inking oscillograph featuring greater flexibility, ease of operation, smaller size and lighter weight; new dual channel, low gain C. D. amplifier for use with double channel recorder, high input impedance. Direct inking oscillographs, associated amplifiers.

In Attendance: H. A. Stearns, Mgr. Instrument Sales; E. M. Hensley, Instrument Sales; J. L. Kearns, Representative.

Buffalo Meter Co., Buffalo, N. Y.....319

Exhibiting: New Niagara chemical meters, volumetric displacement meters made of type 316 stainless steel for measurement of all chemicals which permit of measurement by this metal at flows from 3 to 150 gpm. Niagara liquid meters for cold water, hot water, oils, solvents, syrups, etc.

In Attendance: Herbert F. Barrett, Sales Mgr.; Economy Equipment Co., St. Louis representatives.

Builders-Providence, Inc., Providence, R. I.....616

Exhibiting: Conveyoflo Meter for metering and controlling flow, provides continuous integration, automatic totalizer compensation and can be used for control of secondary liquid or dry feeders; Chlorinizer-Chlorine-Feeder for metering chlorine gas and to produce a chlorine water solution to point of application, contains Sightflo chlorine rate indicator.

In Attendance: W. W. Adams, Ass't Sales Mgr.; W. D. Rouviere, Sales Engr. & Mgr. Conveyoflo Sales; M. H. Strickland, St. Louis Rep.

Bureau of Aeronautics, Dept. of Navy, Washington, D. C.....107, 109

Exhibiting: New Type G-2 Compass, a compass slaved directional gyro; new maximum allowable airspeed indicator, indicates air speed and a maximum safe air speed; new Type H-3 gyro horizon indicator, incorporates a non-tumbling gyroscope; new capacitor type fuel indicator gage with no moving parts. Current production airspeed indicator, altimeter, rate of climb indicator, various pressure gages, tachometers, flow meters, compasses and gyro flight instruments, operating capacity type fuel quantity gage, oscillating table stabilized by a P-1 Autopilot, a typical airplane instrument panel.

In Attendance: Personnel of Bureau of Aeronautics.

Bureau of Ordnance, U. S. Navy, Washington, D. C.....224

Exhibiting: Raydist and new technique in triangulation. Components of Fire Control Computers.

In Attendance: Michael Goldberg, Head Engineer, Fire Control Section.

Burgess Battery Co., Freeport, Ill. 229

Exhibiting: A. M. Power Units, light weight portable power supply for high voltage applications; dry batteries; dry battery design and development for special applications.

In Attendance: L. D. Foust, Sales Engr.; J. B. Mullen, Engr.; L. H. Harriss, Sales Mgr.

Calidyne Company, Winchester, Mass. 631

Exhibiting: New Model 1 Accelerometer Calibrator, electro-dynamic unit for calibrating accelero-meters; new Model 6C Vibration Pickup Calibrator; new Model 6 Shaker delivers a 25 pound force over a wide frequency range; new Model 8C Power Supply and 8S Power Supply for driving pickup calibrators and shakers; new Model 3 and Model 23 Calivolters, laboratory standard sources of known potentials over a wide range; new Model 5 Vibration Meter reads vibration levels directly in r m s inches or r m s inches per second when used with standard velocity pickups; new Model 18 Accelerometer.

In Attendance: Thomas Gouzoule, Partner; Robert C. Lewis, Partner; Walfred Wieklund, Products Engineer.

Century Geophysical Corp., Tulsa, Okla. 518, 520

Exhibiting: New strain gauges, accelerometers, vibration pickups, construction seismographs. Oscillographs, amplifiers. Temperature, strain, stress and vibration analysis.

In Attendance: M. E. Morrow, Executive V. P.

UNIVERSITY OF MICHIGAN LIBRARIES

Chicago Metal Hose Corp., Chicago, Ill. 626

Exhibiting: CMH stainless steel, brass, and bronze bellows; CMH expansion joints; Rex-Weld corrugated metal hose; Rex-Tube convoluted metal hose; Rex-Flex stainless steel metal hose; capillary tubing; engineering service.

In Attendance: A. S. Keller, V. P. Sales; T. K. Wells, Regional Sales Mgr., Bellows Div.; A. W. McGuire, Regional Sales Mgr.; Expansion Joint Div.; K. H. Myers, Chief Coordinator, Bellows and Expansion Joint Div.; E. W. Driedger, Dist. Sales Mgr.

Clapp Instrument Co., Webster, Mass. 208

Exhibiting: Process Industry Acragage, new type precision pressure gage.

In Attendance: Arthur S. Brown, Pres.; T. W. Lanman, V. P.

Climax Engineering Co., Tulsa, Okla. 601, 603

Exhibiting: New type 146 DM Continuous Drainer, self contained float with swivel type coupling enabling valve to be rotated 360° for connecting pipe; new type 1532, thru way valve body with the Climax Reversible Topwork Type 1401, a special pressure pilot with low pressure applications for closing main in case of line break; new valves, regulators, supply medium regulator, relay regulators, pressure control pilots, manual controls. Engineering service.

In Attendance: Jimmy Dvoracek, Sales Mgr.; Ross B. Baze, Asst. Sales Mgr.; A. J. Hanssen, Ch. Engr.; T. F. Casey, Paul E. Bowles, J. E. Walker, T. C. McGuire, W. M. McGinnis, F. C. O'Rourke, R. A. Cwik, Salesmen.

Cole Instrument Co., Los Angeles, Calif. 710

Exhibiting: New Model 130 Vibration-Proof Pyrometer with self-contained circuit thermocouple selector switch for industrial applications such as diesel engines, heavy machinery, locomotives, etc. Panel instruments, switchboard instruments, precision portable instrument, shunts, current transformers, industrial analyzers, megohmmeter, insulation tester, decade boxes, phase sequence indicator, rotary switches, surface pyrometer, immersion pyrometer, exhaust temperature pyrometer, wall mounting pyrometer, portable pyrometer.

In Attendance: F. H. Cole, Owner; L. L. Morrison, Sales Dept.; Gordon Fixman, Rep.

Combustion Control Corp., Cambridge, Mass.....740

Exhibiting: Photoelectric and Electronic Flame Failure Safeguards; Programming Controls for oil and gas burners.

In Attendance: John A. Long; George W. King; Norman W. Kathrinus.

Conoflow Corp., Philadelphia, Pa. 414, 416

Exhibiting: New Cono Rotomotor, pneumatic operator with rotating fluid motor and gear drive for throttling control service—shown in operation as a valve assembly; new Cono Pneumatic Cylinder operators with built-in positioning device for throttling control service shown in operation as a control valve assembly and for positioning a typical adjustable transformer. Regulators and regulator-filter combinations; purge assemblies and remote manual control panels; diaphragm operated control valve assemblies.

In Attendance: D. P. Eckman, Consultant; R. B. Werey, Pres.; M. M. Watkins, V. P. & Treas.; J. C. Koch, Sales Mgr.; E. K. Graham, Jr., Ch. Engr.; J. B. Madison, Sales Engr.

Consolidated Engineering Corporation, Pasadena, Calif. 405, 407

Exhibiting: New Torsiograph Type 9 102 featuring Hermetically sealed fluid damping and a magnetic drive coupling with flat response curve over wide range of frequency and amplitude; new ultra-sensitive galvanometers. Recording oscillograph, amplifying systems, pickups, leak detector. A new Mass Spectrometer Analytical Service Plan will be shown and explained.

In Attendance: R. L. Smallman, Director Sales Electro Mech. Instrument Division; H. W. Ruby, Sales Manager, Electro Mechanical Inst. Division, C. J. Underwood, Jr., Sales Engineer, Electro Mech. Instrument Division; A. P. Gifford, Sales Manager, Chemical Inst. Division; R. L. Welch, Sales Engineer, Chemical Inst. Division; George H. West, Manager, Advertising and Sales Promotion.

Continental Equipment Co., Coraopolis, Pa. 223, 225

Exhibiting: Butterfly valves, manual and automatic operation.

In Attendance: A. M. Capper; C. A. Dally; W. F. Hartman.

R. W. Cramer Co., Centerbrook, Conn. 727

Exhibiting: New synchronous motor with differential gear clutch reset and mechanism which provides output speeds from 8 sec. to ¼ RPD. Interval, percentage, multi-contact, pulse, duplex timers; time delay relays; running time meters and small geared synchronous instrument motors.

In Attendance: R. W. Cramer, Pres.; F. R. Brophy, V. P.; R. C. Heyl, V. P.; W. E. Fry, Representative.

Daniel Orifice Fitting Company, Houston, Texas 521, 523

Exhibiting: New Daniel Simplex Plate Holder; Meter Seal Pots. Daniel Orifice Fittings; Piston Controlled check Valves; Fabricated Meter Runs.

In Attendance: W. A. Griffin, General Sales Manager.

Davis Instrument, Div. Davis Emergency Equipment Co., Newark, N. J.....611

Exhibiting: New Continuous Combustible Gas Alarm System employing a new filament principle; new Continuous Recording H2S Analyzer with a range of 0-50 parts per million; new Continuous Recording Flue Gas Analyzer operating on the thermal conductivity principle of gas analysis and employing a unique flow chain assembly with the new Davis Analyzing Cell; new Explosionproof Continuous Gas Alarm; new Continuous Recording Thermal Conductivity Analyzer. Physical analysis of gases and vapors. Continuous and portable instruments.

In Attendance: F. R. Davis, Pres.; F. Taylor, Jr., Gen. Mgr., Inst. Div.; F. J. Schirm, Ch. Engr.

Engineers Specialties Division of Universal Engraving & Colorplate Co., Inc., Buffalo, N. Y.....204

Exhibiting: Kodak Contour Projector for Surface or contour projection inspection of component parts, tools, etc.; AO Optical Projection Comparator for production inspection of contours of close tolerance parts; Stocker & Yale Miniature Contour and Front Surface Projectors; Radius Charts; Protractor Charts; Thread Charts; Magnification Checkers; Scales; Engineers-Glass; See-All Thread Staging Fixtures; Comparator Charts.

In Attendance: W. DeBoer, Plant Manager; A. R. Fultz, Ch. Tool Eng., Eastman Kodak Co., E. C. Polidor, Ch. Eng., Phillip Mayo, Special Prods. Mgr., American Optical Co.

Charles Englehard Incorporated, East Newark, N. J.....412

Exhibiting: Thermal conductivity Analyzer Cell of hard glass, designed for handling corrosive gases, self contained in a temperature controlled flush mounting case. Controlled Atmosphere Transmitter, Thermocouples, Portable CO_2 Analyzer.

In Attendance: C. K. Krause, General Manager; R. Freund, Sales Engineer.

Esterline-Angus Co., Indianapolis, Ind. 237

Exhibiting: Operation recorder, recording milliammeter, recording wattmeter, current transformers.

In Attendance: Chester M. Poor, Adv. Engr.; R. J. Kryter, Sales Mgr.; D. J. Angus, Pres.

Fisher Governor Co., Marshalltown, Iowa 526, 528, 5

Exhibiting: New valve positioner pressure loaded relay operated topwork, Univer Wilkes pressure controller reset Level-Trol, ties panel loaders. Liquid level controller pressure regulators.

In Attendance: P. A. Elfers, V. P.; B. Ro ris & L. E. Eige, Asst. Sales Mgrs.; D. Wa son, H. D. Hale, R. G. Read, W. D. E Se. Sa Engrs.; G. F. Brockett, Ch. Engr.; Engr V. P.; W. J. Fisher, V. P.

Fischer & Porter Co., Hatboro, Pa. 720, 722, 72

Exhibiting: New Ratochlor, chlorine dispensing units, dry-vacuum type; new Pneumatrol control mechanism for automatic control instruments; new Oriflowrator by pass variable area meter for large flows; new Magnasight flow indicator for opaque liquids and slurries; new metal to glass, glass to glass couplings for Pyrex type glass fittings. Flow meters, control instruments, diaphragm valves.

In Attendance: W. A. Diament, V. P.; Steele, Sales Pro. Mgr.; R. W. Fritzsche.

Foster Engineering Company, Union, N. J. 31

Exhibiting: New Type 38SV Safety Valve, Gentzel Design. Relief, back pressure, altitude, float, lever balanced, non return and safety valves; pressure, temperature and vacuum regulators.

In Attendance: H. J. Fortier, Vice Pres. in charge of sales; H. B. Freeman; E. H. Ronsick, H. O. Weiss, Jr.; L. H. Schomaker; G. L. Coffield and R. L. Lewis.

Foxboro Company, Foxboro, Mass. 512, 514, 516

Exhibiting: New improved design Differential Pressure Cell for flow or liquid level measurement; positive leak-proof, packless, bellows-sealed Pneumatic control Valve; reversible-motor Control Valve, narrow Strip Chart Recorder; Electric Integrator for totalizing flow. Multi-Record Dynalog (electronic) Recorder; Model 40 recording controller, EMF Dynalog (electronic controller; type 17 Flow meter; Model 42 Transmitter and Receiver; All-welded stainless steel capillary and bulb.

In Attendance: V. V. Tivy, Manager, Refining Industry Sales; D. H. Fuller, Manager, Electronic Instrument Sales; Russell Milham, Manager, Control Valve Sales; M. B. Hall, Director of Training; J. J. Burnett, Manager, Central Sales Division; A. H. Shafer, Pittsburgh District Manager; E. B. Miller, St. Louis District Manager; E. L. Stark, Dallas District Manager; G. J. Willier, Kansas City District Manager; L. W. Parten, Houston District Manager; J. B. Dealerick, Baton Rouge District Manager; J. J. Connelly, Sales Engineer, Chicago.

Fredric Flader, Inc., North Tonawanda, N. Y.....738

Exhibiting: Teleflight miniature pressure transmitters; Teleflight miniature accelerometer transmitters; Teledyne pressure transmitters; research and development of specialized instrumentation.

In Attendance: G. O. Haglund, Ch. Mech. Engr.; J. C. Lauderback, Liaison Engr.

Fulton Sylphon Div., Robertshaw-Fulton Controls Co., Knoxville, Tenn. 620, 622

Exhibiting: New Packless Valves, many new types and sizes. Temperature controls, packless valves, bellows and bellows assemblies.

In Attendance: F. G. Cross, V. P.; L. S. Dysart, Ass't Sales Mgr.; D. D. Gordon, Sales Engr.; E. D. Rogers, Adv. Mgr.; E. J. O'Brien, Sales Rep.

General Electric Company, Schenectady, N. Y. 726, 728, 730

Exhibiting: Beta Ray thickness gauge; Strain gauge. Metals comparator; Ultrasonic generator Vorbidometer; Turbidometer; Surface roughness scale, Vibration equipment; Photoelectric temperature recorder; Oven tester thermopotentiometer; Temperature indicating devices—DO7, DW71, DD71, DD15.

In Attendance: W. C. Hutchins, Manager, Special Products Division; R. R. Hersin, Manager

Lab Products Section; L. A. Mooney, Special Products Specialist, Chicago; J. P. Thompson, T. R. Hansen, E. L. McLeary, Laboratory Products Section; J. L. McLoughlin, G. Madsen, N. Gildersleeve, Meter and Instruments Division; F. J. Fitzgerald, Exhibit and Display Section.

General Precision Equipment Corp.,
Chicago, Ill. 215, 217, 219, 221

Exhibiting: New Ampro Stylist and Ampro Repeater; new Askania Transometer developed for translating liquid flows to low pressure air signals for measurement and control purposes; all General Precision Laboratory equipment. Ampro Products—slide projector 30-D; silent 8mm. projector 8-A; silent 16mm. projector 16-16; compact sound projector; Premier 20; Stylist; Repeater. Askania Products—unit regulator; Transometer; manual-automatic valve. Bludworth Products—ES-121-A Indicating Depthometer; ES-123 Recording Depthometer. General Precision Products—pH meter; multiple link computer; X-Y recorder. Hertner Products—squirrel cage, polyphase motor; 1-HP series wound motor. Librascope Products—Laboratory and industrial computers.

In Attendance: Ampro Corp.–Charles P. Goetz, Dir. Ind. Sales. Askania Regulator Co., H. J. Velten, Pres.; H. Ziebolz, V. P.; C. E. Tweedle, V. P.; W. W. Wheeler, Sales Mgr.; J. P. Conde, Adv. Mgr.; S. H. Jones, Chicago Dist. Mgr.; E. R. Engstrom, Pittsburgh Dist. Mgr.; N. R. Berman, Proj. Engr.; R. J. Kroth, Sales Engr.; T. H. Filmer, Service Mgr. Hertner Elect. Co.–R. C. Neiswander, Sales Mgr. General Precision Laboratories–H. Barnett, Executive V. P.; S. S. Lee, Customer Relations Div. Librascope, Inc.–J. M. Sims, E. W. Silvertooth.

Gilbert & Barker Mfg. Co.,
West Springfield, Mass. 711

Exhibiting: New Gilbarco instrument housings designed particularly for the petroleum and chemical industries for secure housing of outdoor instruments. Oil heating and service station equipment.

In Attendance: F. E. Neef, Jr., Industrial Sales.

Claud S. Gordon Co.,
Chicago, Ill. 609

Exhibiting: New Atmosphere Indicator to continuously detect and indicate changes in the atmospheres of industrial furnaces; new Xactline Control, an auxiliary electrical input control for pyrometers; new Xactemp Hand Pyrometer for molten metals and general temperature checking. Thermocouples, thermocouple wire, lead wire, thermocouple insulators, metal and ceramic protecting tubes, pyrometer accessories. Pyrometer repair service.

In Attendance: R. J. Ritchie, St. Louis Branch Mgr.; C. S. Gordon, Pres.; Vincent Manka, V. P.; D. E. Howell, Ch. Engr.; W. J. Hammond, Ass't Ch. Engr.; Sales & Service Personnel.

Gow Mac Instrument Co.,
Newark, N. J.....138

Exhibiting: New Model M/K-SS Thermal Conductivity Unit for use with many corrosive gas mixtures; new Model M/K-8 Thermal Conductivity Unit for continuous service, especially recording and control. Thermal conductivity cell units; exhaust gas analyzers.

In Attendance: James L. McFadden, Pres.

Gormac Products, Inc.,
Racine, Wis. 206

Exhibiting: Machined parts for meters, instruments, etc. finished on Swiss automatic lathes to great accuracy and exceptionally fine surface finish. A variety of instrument parts.

In Attendance: Raymond Roseth, Factory Supt.; J. T. Simmons, Factory Mgr.; Harold F. Nelson, Sales Engr.

L. F. Grammes & Sons,
Allentown, Pa. 325

Exhibiting: Name plates, scales, dials, bezels, escutcheons, stampings, wire formings. Sales promotion aids, Etching, embossing, lithographing, plating, enameling, soldering, assembling.

In Attendance: Robert W. Weindel, Donald Stephens, Glen Stouffer, Sales Representatives.

Hagan Corp.,
Pittsburgh, Pa. 608, 610

Exhibiting: Hagan Ring Balance wide range pressure and temperature compensated flow meter; dual meter; meter with glass ring; 10000 p.s.i. flow meter; Hagan Thurstorque; variable ratio totalizer.

In Attendance: O. B. Vetter, Ch. Engr., Ring Balance Div.; M. J. Boho, Mgr. Sales; R. R. Donaldson, V. P.; M. S. Gare, Mgr., Ring Balance Div.

Hammel-Dahl Co.,
Providence, R. I.....210

Exhibiting: New complete set 1", 1½", 2", 3", 4" 1500 lb. ASA Venturiflo angle valves; new Microflo control valve with 3000# stainless steel body, solid Stellite spline plug, diaphragm control valve with cast iron body; diaphragm control valve equipped with continuously connected handwheel; supersensitive gas regulator; Type 3644-BSZ diaphragm control valve, stainless steel body with 300# ASA standard flanged ends; Venturiflo angle valve with 600# cast steel ASA flanged body with Venturi throat; 15000# high pressure angle valve. Diaphragm operated control valves. Flow, liquid level, pressure and temperature control engineering.

In Attendance: E. T. Dahl, Pres.; B. A. Irwin, V. P.; Otto Kneisel, Dev. Engr.; J. R. Curran, Design Engr.; David Golner, Robert Carter, Wayne Farley, Harold Miller, J. E. Charsha, Sales Engrs.

Hays Corp.,
Michigan City, Ind. 313

Exhibiting: New Magno-Therm, oxygen analyzer employing principle based on paramagnetic property of oxygen; new Acratron, an electronic type of self-balancing AC potentiom-

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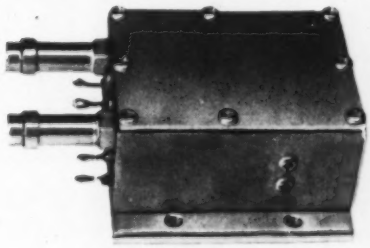

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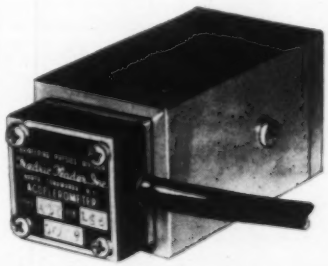
- **Custom Instrumentation**



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eter; new Magna-Clutch, a higher accuracy mechanical flow meter. Electrically operated automatic combustion control, water operated CO_2 recorder, mechanical and electrical types of flow meters, remote indicating flow meter, multible combustion testing instrument, portable draft gages, and draft gages for permanent mounting.

In Attendance: P. T. Sprague, Pres. & Gen. Mgr.; S. M. Rudolph, V. P. Sales; W. H. Pugsley, V. P. Field Research; F. I. Lackens, Ad. Mgr.; Orval Riggs, Ch. Project Engr.; Jack Tipton, Project Engr.; Clarence Miller, Project Engr.; Phil Sprague, Jr., Ass't Ad. Mgr.

Heiland Research Corporation, Denver, Colo. 621

Exhibiting: New Oscillograph Recorder and Carrier Amplifier; Cathode Ray Recorder; Galvanometers.

In Attendance: Dr. C. A. Heiland, President; Donald B. Clow, Manager; Instruments Sales and Development.

Helicoid Gage Div., American Chain & Cable Co., Bridgeport, Conn. 527

Exhibiting: New illuminated dial gages; new chemical gages. Helicoid gages.

In Attendance: Joseph V. Tracy, Sales Mgr.; Ernest H. Grauel, Chief Engr.

Hills McCanna Company, Chicago, Ill. 120

Exhibiting: Hills McCanna Hydraulic Drive "K" metering and proportioneering pumps with pneumatic stroke control; L-1 Plastic Diaphragm Valves on 66° Be Sulphuric Acid Service. Diaphragm Valves, handwheel and air cylinder operated.

In Attendance: R. T. Kidde, A. & M. R. McFarland, Technical Director.

Holtzer-Cabot, Inc., Boston, Mass. .....20[illegible]

Exhibiting: New RBDS-0810 Sub-[illegible]niature Servo Motor for aircraft instrument applications requiring extreme accuracy, weight 8 o[illegible] operates on field current of 6 milliampe[illegible] with stalled armature, current of 8 amper[illegible] up to 14,000 R.P.M. Type R-25 instrument [illegible]motors, electronically controlled insulation [illegible]istance tester.

In Attendance: C. L. Heckncan, Sal[illegible] Mgr.; Frank Anderson, Sales Engr.; A. E. Smith, Adv. Mgr.

Illinois Testing Labs., Inc., Chicago, Ill. 716, 718

Exhibiting: New electric thermo-anemometer for precise measurements of air velocities; new dew pointer for accurate measurement of dew points between room temperature and minus 100°F. Pyrometers, electric resistance thermometers, air measuring instruments. Electrical instrument, pressure gauge and recording thermometer repairs.

In Attendance: Frank Fillo, A. A. Obermaier; W. J. Bailey.

Industrial Instruments, Inc., Jersey City, N. J. 615

Exhibiting: New "Auto-Bridge" automatic sorting machine for resistance, capacitance and inductance; electrolytic conductivity recorder with automatic temperature compensation; electrolytic conductivity bridges and conductivity cells; battery-operated conductivity bridge. "Solubridge"; Wheatstone bridges; resistance decades; capacity decades; voltage breakdown testers; complete panel assemblies; special apparatus.

In Attendance: Philip M. Gotthold, Pres.; Dr. R. Rosenthal, Ch. Chemist.

Industrial Pyrometer and Supply Company, Alton, Ill. 519

Exhibiting: New plastic sheath pyrometer wires, lighter, smaller, more flexible than conventional lead sheath, inert to most chemicals, self-extinguishing, resistance to oil gasoline and moisture. New general all purpose rust-proof thermocouple head for any size thermocouple, gas tight, light weight, compact. Insulated thermocouple lead wires, Bare thermocouple wires, protection tubes, connection heads and complete thermocouples.

In Attendance: Frank L. Hack, Asst. General Manager, Alex J. McBride, Sales Division.

Industrial Trends, New York, N. Y. 114

Exhibiting: Industrial Trends, a publication.

In Attendance: H. J. Weinberger, Editor; S. I. Eagle, Circulation Mgr.

Institute of Radio Engineers, New York, N. Y. 624

Exhibiting: 1949 IRE yearbook listing 17,900 Radio Engineers; Directory of 3347 Firms serving the Industry; Proceedings of the I.R.E.

In Attendance: William C. Copp, Dayton M. Jones.

Instruments Publishing Co., Pittsburgh, Pa. 137

Exhibiting: "Instruments," the Magazine of Measurement and Control; "The Instrument Index," the Bi-annual Directory of the Instrument Industry; "The Instrument Maker," the Trade Journal of the Instrument Industry. Books: Scientific and Industrial Glass Blowing and Laboratory Techniques" by Barr and Anhorn; "Elementary Engineering Electronics" by Andrew Kramer.

In Attendance: Richard Rimbach, Publisher; M. F. Behar, Editor; Richard Rimbach, Jr., New York Rep.; J. R. Wright, St. Louis Rep.; H. W. Haskett, Chicago Rep.; C. F. Goldcamp, Pittsburgh Rep.

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KEENE, NEW HAMPSHIRE, U.S.A.

International Nickel Co.,
New York, N. Y. 102

Exhibiting: New electrical computer will flash various combinations of 31 properties of 17 metals and alloys. Monel, malleable nickel, Inconel, Inco nickel alloys in all commercial forms—sheet, strip, rod, wire, tubing, forgings, castings, special shapes, etc.

In Attendance: B. B. Winter, P. F. Sheridan.

Jerguson Gage & Valve Co.,
Somerville, Mass. 617

Exhibiting: New Truscale distant reading gage complete with audible and visible alarms; new series RF non-frosting gage; new series TT heated-cooled gage and valve unit. Gages and Valves.

In Attendance: James A. Ford, Sales Mgr.; Robert C. Stanley, Asst. Engr.

Kay Electric Co.,
Pine Brook, N. J. 209

Exhibiting: New Sonalator, a dynamic translator for visible speech; new Sonagraph, a sound spectrograph for the frequency analysis of audio energy.

In Attendance: Harry R. Foster, Elmo E. Crump.

Kelley-Koett Manufacturing
Company, Inst. Div.
Covington, Ky. 641

Exhibiting: New Alpha Beta Gamma Survey Meter; Pocket Audio Detector; Alpha Survey Meter (Zeuto); Beta Gamma Survey Meter; Ion Chamber Gamma Survey Meter; Uranium Locater (midget size). Dosimeters, Scalers, Slow Neutron Chambers, Gamma Pocket Chambers.

In Attendance: L. E. Rasmussen, General Mgr. & H. R. Levinger, Sales Mgr.

Kieley & Mueller, Inc.,
North Bergen, N. J. 318, 320

Exhibiting: Diaphragm motor control valves and allied equipment.

In Attendance: Ward K. Stallings, Ch. Engr.; A. W. Bailey, Sales Engr.; R. J. Donnelly, Sales Mgr.

Leeds & Northrup Co.,
Philadelphia, Pa. 742, 744

Exhibiting: New Double-element Speedomax Recorder automatically plots curve showing relation between two simultaneously variable functions such as flux density and magnetizing force, temperature and elongation, etc. 50-Point Speedomax Temp. Indicator; Multiple-Point Speedoman High-Speed Recorder; Multiple-Point Micromax Recorder; L & N Pneumatic Controller; Electromax Non-Indicating, Non-Recording Controller; Thermohm Resistance Thermometer for temp. up to 1000 F; Open-Dial Switch Wheatstone Bridge; Type E Enclosed Lamp and Scale Galvanometer.

In Attendance: A. E. Tarr, Mgr., Ind. Sales; L. E. Emerich, Mgr., Tech Sales; G. C. Graf, Mgr., Market Extension Div.; J. F. Schock, D. J. Lane, J. W. Harsch, J. F. Quereau, Engrg. Dept.; N. Cohn, Chicago Office; T. C. Bennett, A. C. McGraw, A. H. Albertson, Jr., W. S. Bloor, H. L. Daneman, J. C. Doty, R. C. Miller, R. L. McKee, J. F. Sneath, Chicago Office Field Engrgs.; P. K. Welch, A. A. Degling, R. S. Day, St. Louis Office Field Engrgs.; E. R. Fiske, Jr., R. J. Casler, Adv. Div.

Leslie Co.,
Lyndhurst, N. J. 409, 411

Exhibiting: Pressure reducing valves, pressure controllers, pump governors, temperature regulators, strainer, whistles, signals.

In Attendance: J. S. Leslie, Pres.; R. W. Boettiger, Sales Mgr.; S. R. Brown, Sales Engr.; A. J. Dromm, Sales Engr.; Harold G. Jones, Bruce Greaves, W. Mooney, Agents.

Magnetrol Inc.,
Chicago, Ill. 317

Exhibiting: New Models A-100 and A-150 for controlling level of liquid in vertical or horizontal, open or closed sumps and tanks, displacement principle; new Flow Switch for chemical processes. Liquid level controls for practically any liquid, at any temperature, at any pressure. Consulting service.

In Attendance: B. L. Binford, Ch. Engr.; L. E. Stybr, Sales Mgr.; District Representatives.

Manning, Maxwell & Moore
Incorporated,
Bridgeport, Conn. 122, 124

Exhibiting: New Ashcroft pneumatic pressure transmitter and receiver; new Microsen electrical pressure transmitter and receiver; new Nylon rotary geared gauge movement. Ashcroft gauges. American industrial instruments, Hancock valves, Consolidated valves.

In Attendance: E. F. Nordstrom, Prod. Mgr. Insts., E. M. Dederer, Prod. Mgr. Gauges; C. N. Sugden, Ch. Engr. Gauges; H. M. Moore, Sales Manager, Mid Western Dist.; R. C. West, Sales Manager, Mid-Continent District; O. R. Ruff, W. J. Cotter, C. F. Lane, A. C. Stauch, Salesmen.

Mason-Neilan Regulator Co.,
Boston, Mass. 803, 805, 807

Exhibiting: New No. 2700 pressure controllers, small compact non-indicating controllers includes pneumatic proportionality accomplished with feed-back bellows and cantilever leaf spring. New No. 12000-40 Explosion Proof Level Switch combines level measurement by displacement principle with mechanically operated explosion proof switch. Diaphragm control valve, liquid level controllers, pressure regulators, valve positioners, instruments for pressure and temperature control; pneumatic switches.

In Attendance: J. J. Hourihan, Sales Engr. in charge.

McAlear Manufacturing Co.,
Chicago, Ill. 715

Exhibiting: New #1500 Pressure Pilot, featuring indicator for set pressure, conversion of pilot from direct to reverse acting, spiral sensitive spring. Various types diaphragm valves and controllers. Engineering for automatic regulation of air and fluids in pressure relief, pressure reducing and controlling flows of fluids.

In Attendance: Mr. Ludvik, Pres.; Mr. Cook, Ch. Engr.; Messrs. Skoropad and Vander Ploeg.

Meriam Instrument Co.,
Cleveland, Ohio 701, 703

Exhibiting: New high pressure manometer for

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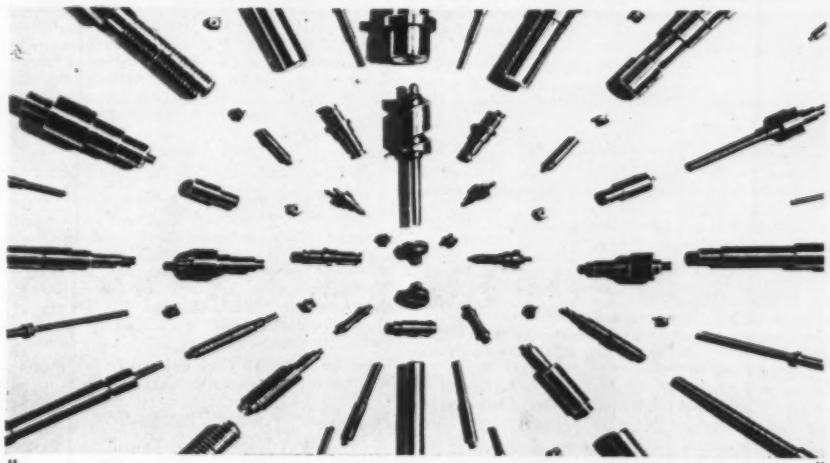

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In Attendance: J. B. Meriam, Jr., Pres.; A. A. Hejduk, V. P.; Mark Meriam, Sales Engr.; Sales Reps.

Metal Goods Corp., St. Louis, Mo. 131

Exhibiting: New Childers Metal Jacketing, flexible, light-weight aluminum with corrugated ribs affords great protection when wrapped around lines. Parker fittings and valves; Imperial fittings and valves; Dragon valves; Handy & Harman silver brazing alloys; Tubing, all metals; Fastening, all types; Instrument board equipment.

In Attendance: Thomas G. Rankin, Manager, Accessories Div.; Melvin E. Brown, Asst. Mgr. Accessories Div.

Milton Roy Company, Philadelphia, Pa. 415

Exhibiting: New Titronic System for automatic concentration control by continuous titration; new Constametric Pump, controlled volumsic, positive displacement, metering pump delivers constant flow without pulsation. Plastic Pump with Thymotrol capacity control. Chemical Engineers on chemical feed applications.

In Attendance: R. T. Sheen, President; Wm. C. Griffiths, Chemical Engineer; R. L. Claypool, W. C. Brockelman, D. A. Claypool, District Engineers.

Miniature Precision Bearings, Keene, N. H. 404

Exhibiting: New special ball bearings in miniature sizes. Precision ball bearings.

In Attendance: Geo. E. Kunhardt, Jr., Treas.; Wm. L. Timmerman, Engr.

Mine Safety Appliances Company Pittsburgh, Pa. 623, 625

Exhibiting: New Infra Red Analyzer to detect and measure individual components in complex gaseous and liquid mixtures. Gas, dust and fume detectors and recorders.

In Attendance: N. W. Hartz, Ind. Department, R. V. Fitzpatrick and C. R. Dever, Field Representatives.

Minneapolis-Honeywell Regulator Co., Brown Instrument Div., Philadelphia, Pa. 324, 326, 328

Exhibiting: New flush type indicating millivoltmeter pyrometer controller; new flush type excess temperature cut-off millivoltmeter pyrometer; new multi-record strip chart electric control Electronik potentiometer; new double range circular chart pneumatic control Electronik potentiometer; new Manual-Automatic-Regulator for positioning instrument control settings from a remote location; new Manual-Automatic-Controller with indicating process variable dial, containing built-in by-pass; new precision indicator providing laboratories accuracies of reading; new pneumatic set ratio control recorder; new high speed resistance thermometer bulb; new Belfield displacement type indicating level controller. Indicating Electronik Potentiometer controller; Electronik resistance thermometer recorder; Protectoglo; Belfield valves including high and low-lift diaphragm models, pilot piston types, electric motor actuated styles and springless motor; Minneapolis-Honeywell non-indicating controllers.

In Attendance: W. H. Steinkamp, Field Sales Mgr.; K. R. Knoblauch, Mgr., Market Extension & Sales Promotion; W. H. Schmitt, Mgr., Chemical Industry; J. R. Green, Mgr., Steel & Ceramic Industries; A. W. Roat, Ind. Mgr., St. Louis, M. G. Roberts, Salesman.

Moran Furnace and Sheet Metal Company, Tulsa, Okla. 702, 704

Exhibiting: Meter Houses, Safety Heaters Mercury Protectors; Chart Carrying Cases and other Safety equipment. All of the above items are for Instrument Protection.

In Attendance: W. O. Moran, Owner; W. E. Morris, Representative.

Nash Engineering Co., South Norwalk, Conn. 129

Exhibiting: New instrument air compressor in operation under test conditions demonstrating ability to deliver absolutely clean instrument air without oil filters, dust filters or after coolers. Nash Clean-Air Brand compressor.

In Attendance: I. C. Jennings, Pres.; E. A. Mead, Gen. Sales Mgr.; H. E. Adams, Ch. Engr.; W. M. Thomson, Asst. Sales Mgr.; J. B. Wright, Mgr. Building Sales; F. W. Green, Mgr. Industrial Sales; E. A. Barton, Sales Engr.; G. B. Wright, Publicity Mgr.

National Bureau of Standards, Washington, D. C. 321, 323

Exhibiting: Rectangular pulse power generator at adjustably variable width and repetition rate, utilizing a novel electronic switch which rapidly turns power on and off; atomic standards of frequency and time; unification of screw threads between the United States, Great Britain and Canada.

In Attendance: Chas. L. Bragaw, Technical Reports Section; J. Sargeant, Mechanical Instrument Section.

National Technical Laboratories, South Pasadena, Calif. 406, 408

Exhibiting: New Beckman Automatic Titrator, electrometric titration in which the titrating liquid is delivered automatically to a preset end point. pH meters, spectrophotometers, radiation meters, and micro-microammeters.

In Attendance: Dr. A. O. Beckman, Pres.; T. F. Herring, V. P.; W. W. Blalock, Dr. E. D. Haller, G. R. Kincaid, Sales Engrs.; Marshall Odeen, Sales Dev.; Paul Ayers, Service.

Naval Ordnance Laboratory, White Oak, Silver Spring, Md. 220, 222

Exhibiting: Cutaway Torpedo complete with exercise head, extender and instrumentation; Universal Magnetometer used for detecting submarines from an airplane, for studying the Earth's magnetic field and for geophysical prospecting; Spiral Laminagraph for X-Rays of an object, showing one plane sharp and other planes blurred.

In Attendance: Carl Acker; L. W. Freud; D. R. Church; Raymond E. Miller.

North American Philips Co., Mount Vernon, N. Y. 413

Exhibiting: New high intensity water cooled X-Ray Diffraction equipment and all accessories including powder camera, precision-back reflection camera, micro X-Ray diffraction camera, flat plate camera; new high angle, high intensity, high resolution Geiger-Counter X-Ray Spectrometer Goniometer with associated electronic equipment; new equipment for isotope research including scalers, rate meters, high voltage units and Geiger-Counter tubes.

In Attendance: C. J. Woods, Nat. Ind. Sales Mgr.; John Buhler and W. C. Elliott, Dist. Sales Mgrs.

Palmer Thermometers, Inc., Cincinnati, Ohio 705, 707

Exhibiting: Industrial, laboratory, dial and recording thermometers.

In Attendance: Bartlett Palmer, Pres.; Frank Probst, Sales & Service Engr.; Douglass H. Hitt, Sales Dept.

Panellit, Inc., Chicago, Ill. 401, 403

Exhibiting: New Panelgraph utilizing anodized aluminum strips in color for mimic pipe lines and anodized symbols; new Level Receiver illuminated edgewise indicating receiver with high and low contacts; new Series 400 Panalarm hermetically sealed multiple alarm units. Prefabricated panels and cubicles, Panalarm signals, indicating pressure switches.

In Attendance: A. F. Sperry, Pres.; M. B. Lorig, Ch. Engr.

Penn Industrial Instrument Corp., Philadelphia, Pa. 313

Exhibiting: New Penn pneumatic indicating or indicating-controlling transmitters for temperature, pressure, level and flow have a linear output of 3 to 15 psi.; new Penn pneumatic recording receivers, bellows operated, employ 12" chart and have 1, 2, 3, or 4 pens, or with 1 or 2 pens one of which may operate a [illegible] type of flow integrator; new Penn 12 [illegible] corder-controller supplied with on-o[illegible] tional band, rate response and reset [illegible] tion, available for temperature, pres[illegible] and level; new magna-clutch mano[illegible] tinguished by substitution of magnet[illegible] for conventional stuffing box and by [illegible] for range adjustment. Penn temper[illegible] pressure recorders; Hays-Penn flow [illegible] meters.

In Attendance: Wm. C. Bennett, P[illegible] & Co. Mgr.; Wm. Melas, V. P. & Ch. Engr[illegible] F. Ward, Design Engr.

Perkin Elmer Corp., Glenbrook, Conn. ..... 2[illegible]

Exhibiting: New Double Beam Infra[illegible] trophotometer. Flame photometer. Tise[illegible] trophoresis apparatus. High sensitivity D[illegible] Amplifier.

In Attendance: Dr. V. Z. Williams, Directo[illegible] Inst. Dev. & Sales; Paul A. Wilks and Wm. J. B[illegible] Hargrave, Sales Engrgs.

Photoswitch, Inc., Cambridge, Mass. ..... 74[illegible]

Exhibiting: New Smoke Control series 25 in[illegible] troducing advanced photoelectric design; new Photoelectric Fire Detector. Photoelectric con[illegible] trols, counting equipment, electronic timers, electric level controls, other industrial electroni[illegible] controls.

In Attendance: John A. Long, Exec. V. P.; George W. King; Norman W. Kathrinus.

Physicists Research Company, Ann Arbor, Mich. 101, 103, 105

Exhibiting: Profilometer, direct reading shop instrument for measuring surface roughness. Proficorder, for recording waviness, roughness and other surface profiles; Wavometer, direct reading shop instrument for measuring waviness on surfaces or rotation; Anderometer, direct reading high speed shop instrument for obtaining over all qualitative rating of assembly and ball bearings.

In Attendance: Ernest J. Abbott, Manager; Fred J. Engelke, Frank W. Kabat, Field Representatives.

Precision Thermometer and Instrument Company, Philadelphia, Pa. ..... 20[illegible]

Exhibiting: Densitrol continuous liquid density measuring equipment in new constructions suitable for all corrosive conditions and sanitary requirements. Thermometers, Hydrometers, Barometers.

In Attendance: W. D. Laverell, V. P.; Carl Waser, President; J. Boonshaft, Chief Engineer; J. Huber, Local Representative.

Precision Tube Co., Inc., Philadelphia, Pa. ..... 52[illegible]

Exhibiting: New Nispan-C, high strength heat treatable nickel alloy. Precision non-ferrous metal tubing and precision coaxitube and Bourdon gauge tubing.

In Attendance: Norman H. Jack, Jr., Secy-Treas.; Chester Pondo, Met.; Albert J. Armstrong, Prod. Mgr.; Matthew F. Balch, Jr.

J. F. Pritchard & Co., Kansas City, Mo. ..... 3[illegible]

Exhibiting: New Custom-built Hydryer for drying instrument air, capacity 500 scfm. at 4[illegible] psig.

In Attendance: F. L. Spies; L. C. Sandy; R. E. Bradley.

Proportioneers, Incorporated, Providence, R. I. 618

Exhibiting: New differential type continuous volumetric blending system for two or more liquids which will automatically control ratios of liquids to within ½ of 1%, designed for lubricating oils, gasoline or chemical process requiring multiple blending. Constant rate motor driven Adjust-O-Feeder pump; Flow responsive hydraulically operated Treet-O-Unit proportioning pump. Engineering service on proportioning problems.

In Attendance: R. P. Lowe, President; P. V.

Crowther, Industrial Engineer; M. H. Strickland, Special Representative, St. Louis; H. W. Ardizer, Tulsa Representative; C. E. Lennox, Chicago Representative; W. O. Metcalf, Kansas City Representative; D. H. Abbott, Cincinnati Representative.

Pyrometer Instrument Co.,
Bergenfield, N. J. 613

Exhibiting: New Pyro radiation tubes; new radiation pyrometer complete with water cooling jacket or air cooling fins; new target tube and indicating pyrometer. Optical, radiation, surface, immersion and indicating pyrometers.

In Attendance: P. V. Bollerman, V. P.; A. Bollerman, Pres.

R-S Products Corporation,
Philadelphia, Pa. 106, 108

Exhibiting: Valves, Control and Shut Off; Electronic Control; Strainers, 3" and larger, level control.

In Attendance: Russell C. Ayers, Sales Manager; Donald Culver; Russell Patton; John Patton.

Republic Flow Meters Co.,
Chicago, Ill. 522, 524

Exhibiting: Combuston control; regulators; pneumatic transmission; electric transmission; integrating meter; multi-pen chart recorder. Combustion control, process control, instrumentation engineering.

In Attendance: J. B. McMahon, Sales Pro. Mgr.; E. N. Davidson, St. Louis Dist. Mgr.; W. L. Eckdehl, R. Benninghoven, Sales Engrs.

Refinery Supply Co.,
Tulsa, Okla. 605, 607

Exhibiting: New Liquid Gravitometer for specific gravity determination of liquids. Midget industrial Thermometers and gas testing specialties.

In Attendance: W. A. Schlueter, Pres.; J. B. Okeson, Sales Mgr.; H. F. Goodenough, Engr.; V. F. Sweeney, W. W. Ansteth, Sales Reps.

Roller-Smith,
Bethlehem, Pa. 104

Exhibiting: New type S-3 improved socket type watthour meters; new type R-4 miniature rotary switches; new Model 500 high sensitivity volt-ohm-milliammeters. Panel, switchboard, portable and special instruments, relays, switches and precision balances.

In Attendance: E. S. Maury, Sales Mgr.; J. E. Miller, Engr.; C. P. Lohr, G. Stebbins, St. Louis office.

Rubicon Company,
Philadelphia, Pa. 627, 629

Exhibiting: New Recording Continuous-flow Differential Filter Photometer for automatic measurement of color density or light absorption of fluid streams; new Model B Skin Temperature Indicator. Type B high precision potentiometers; portable potentiometers; Wheatstone, Kelvin and Mueller bridges; standard resistors; decade resistance boxes; spotlight and pointerlight galvanometers; photoelectric galvanometer and recorder; Evelyn photoelectric colorimeter; recording automatic hydrogen sulfide analyzer.

In Attendance: W. H. Schaeffer, Sales Manager; P. M. Andress, Sales Engineer, J. D. Cox, Sales Engineer.

Sanborn Company,
Cambridge, Mass. 227

Exhibiting: Several models with and without associated amplifiers of the Sanborn Direct-Writing Recorders, featuring permanent records, made without ink and having true rectangular coordinates.

In Attendance: A. E. Lonnberg, Sales Manager; Dr. Arthur Miller, Electrical Engr.

Schutte & Koertjng Co.,
Philadelphia, Pa. 142, 144

Exhibiting: New pneumatic, recording and controlling rotameters available with receivers manufactured by most instrument companies. Indicating rotameters, high pressure rotameters, recording rotameters, flow indicators, specific gravity indicators, electric recording rotameters, electronic recording rotameters, pneumatic recording rotameters.

In Attendance: H. W. Gripton, Engr.; W. Gerber, Electrical Engr.; F. J. Passen, Sales Engr.

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Shallcross Mfg. Co., Collingdale, Pa. 410

Exhibiting: New portable standard resistor; single high-precision resistors; weather-proof type precision resistors; subminature and minature precision resistors; high-voltage divider for DC and AC; portable self-contained Kelvin-Wheatstone bridge; portable self-contained Kelvin bridge; portable self-contained combined potentiometer and Wheatstone bridge; portable self-contained fault location and Wheatstone bridge; transmission gain test set. Measuring bridges; service instruments; resistors and attenuators. Research, designing, and development of instruments and resistance networks.

In Attendance: D. H. Shallcross, Pres.

Sig-Trans, Inc., Amesbury, Mass. 110

Exhibiting: New generators and motors with self-synchronous units for electrical transmission of data from one point to another; complete instruments incorporating all units. Self-synchronous transmitting generators; motors; differential motors and control transformers; industrial signal transmission systems; Marine electrical telegraph equipment.

In Attendance: S. N. Mead, Pres.

Simplex Time Recorder Co., Gardner, Mass. 517

Exhibiting: New automatic reset printing interval timer, prints on impulse manual or automatic, elapsed time expressed in minutes and hundredths of minutes on running tape. Time recorders, job recorders, time stamps, Productograph, Temporator. Payroll and job time recording, time study and production control recording, autoscaler radio isotope timing and counting measurements, angular measurement recording against time base.

In Attendance: C. C. Richelieu, Sales Mgr.; Henry Rixford, Ch. Engr.

South Bend Lathe Works, South Bend, Ind. 637, 639

Exhibiting: New 14" precision drill presses, bench and floor models, lever controlled, wrenchless type belt tension release mechanism; new precision bench shaper and steel stand. Precision lathes; 14" drill presses, 7" bench shaper.

In Attendance: C. L. Miller; R. W. Planck; P. E. George.

The Superior Electric Co., Bristol, Conn. 633, 635

Exhibiting: New STABILINE voltage regulators, types IE51002, IE002R, EM4102. POWERSTAT variable voltage transformer. Stabiline automatic voltage regulator, VOLTBOX a-c power supplies and 5-way binding posts.

In Attendance: A. B. Nelson, Pres., T. L. Hannon, V. P., J. S. Louden, Sales Mgr., R. J. Caccavelli, Sales Engr.

Specialty Battery Co., Madison, Wis. 118

Exhibiting: Dry batteries for all types of application and services.

In Attendance: N. D. Vea, Pres.; Howard E. Jordan, Sales Engr.

Standard Electric Time Co., Springfield, Mass. 402

Exhibiting: New Photo Electric Tachometer. Timers and tachometers and electrical connectors.

In Attendance: E. S. White, S. C. Jordan, O. H. Rottman, S. G. Yonkers.

Streeter Amet Company, Chicago, Ill. 202

Exhibiting: New scientific and industrial recording counter equipped with repeat cycle timer designed to give a printed count after any preselected period of time has elapsed, Automatic weight recorder; Permanent Station Traficounter; Recording Traficounter; Traficounter, Junior.

In Attendance: V. C. Kennedy, Jr., Supr. of Engrg.; G. F. Graham, Sales Dept., John Marquardt, Electronic Engineer, Paul Becher, Supvr. Counter Dept., W. R. Daniels, Sales Dept.; D. R. Jones, Engr. Dept.

C. J. Tagliabue Corp., Newark, N. J. 134, 136

Exhibiting: Tag indicating, recording, controlling, thermometer and pressure gages; dial, industrial and laboratory thermometers; Celetray potentiometers; Tag-Heppenstall moisture meters.

In Attendance: C. W. Stafford (in charge); A. G. Koenig, Gen. Sales Mgr.; J. F. Bailey, C. L. Huffman, F. Kirk, E. F. Schimbor, R. C. Staub, Dist. Mgrs.

Taylor Dynamometer and Machine Co., Milwaukee, Wis. 140

Exhibiting: Taylor HI-EFF Sensitive Drilling Machine, drills holes to 0.002 with minimum run out, speed 40,000 rpm.

In Attendance: Arthur C. Flamme, Partner; Charles E. Chavez, Partner.

Taylor Instrument Companies, Rochester, N. Y. 719, 721, 723

Exhibiting: New temperature Transaire, force balance temperature transmitter having unprecedented speed of response and incorporating Speed-Act, a new concept in detection of temperature variations, barometric and temperature compensated; new Pressure Transaire for short suppressed ranges up to 400 p.s.i., ranges are 20 to 40 p.s.i.; new 10" concentric dial receiver or flow transmitter; new Flex-O-Timer time cycle controller, pneumatic and/or electrical functions, wide range of adjustable speeds; new 4" x 4" Transet panel and control system with automatic--manual units. Fulscope controllers, aneroid and mercury manometers, liquid level transmitter, flow transmitter, self acting temperature controller, industrial thermometers, laboratory thermometers and hydrometers.

In Attendance: R. E. Olson, Gen. Sales Mgr.; F. S. Ward, Ind. Sales Mgr.; A. J. Fleig, Div. Sales Mgr.; J. S. Detwiler, Div. Sales Mgr.; R. E. Clarridge, Mgr. Application Engrg.; R. Reamer, Application Engr., R. N. Pond, Ind. Sales.

Telechron, Inc., Ashland, Mass. 604

Exhibiting: Synchronous timing motors and chart drives, interval timers, automatic switch and signal timers.

In Attendance: C. B. Dix, Mgr., Motor Sales.

Tracerlab, Inc., Boston, Mass. 517

Exhibiting: New Automatic Sample Changer providing radioassay results of large numbers of radioactive samples; new Beta Gauge, a noncontacting thickness gauge for measuring sheet material such as paper, plastic, rubber, metals, etc. Geiger tubes, radioactivity scaling instruments. Research and consultation in radioactivity.

In Attendance: D. W. Atchley, Sales Mgr.; A. P. Schreiber, L. W. Mead.

Trimount Instrument Company, Chicago, Ill. 233

Exhibiting: Manometers, Gauges, Flowmeters, Smoke indicators.

In Attendance: J. L. Mayer, President; E. Kreml, Secretary; J. H. Huber, Representative.

Trinity Equipment Company, Roselle Park, N. J. 218

Exhibiting: Thermowells.

In Attendance: George R. Feeley, Pres.; James V. Mannion, Vice-President in charge of manufacturing.

Uehling Instrument Co., Paterson, N. J. 123

Exhibiting: Absolute pressure indicators, absolute pressure recorders, liquid level indicators, vacuum indicators, pressure gauges, pressure and vacuum gauges, draft gauges, mercurial barometers, vacuum recorders, manometers.

In Attendance: C. J. Schmid, Alexander Foth, Sales Engrs.; P. J. Riccobene, Sales Mgr.; Wm. Justice, Pittsburgh Rep.; Larry Burroughs, Wm. Lukens, Sherman Engineering Co., Philadelphia Reps.

U. S. Naval Ordnance Test Station, Inyokern, Calif. 125, 127

Exhibiting: Naval Ordnance items and instrumentation for ordnance research.

In Attendance: Arthur G. DeBell.

Vapor Recovery Systems Co., Compton, Calif. 706

Exhibiting: New Varec Electronic Gauger, for remote liquid level determination of any number of tanks from centrally located position; High-low level alarm for use with Electronic Gauger. Automatic tank gauges featuring patented gravity compensator. Float type gauge for liquid level determination at tank site, may be compensated for various tank contents, models for various types of tanks.

In Attendance: C. J. Van Landegh, Sales Mgr.; J. E. White, Jr., Inst. Engr.; L. [illegible] Greer, Ch. Engr.; P. G. Reeves, Electronics Engr.; C. F. Gast, Sales Engr.

Veeder-Root, Inc., Hartford, Conn. 511

Exhibiting: New general purpose mechanical and magnetic counters. Counting devices, reset and non-reset models. Ratchet, revolution, direct drive, rotary ratchet, worm driven and measuring wheel counters.

In Attendance: C. C. Lombardi, Chicago Dist. Mgr.; N. B. Perkins, H. T. Sell, Sales Reps.; R. R. Soderquist, Sales Engr.; G. L. Logan, Dist. Sales Supervisor.

Wallace & Tiernan Products, Inc., Belleville, N. J. 612, 614

Exhibiting: New absolute pressure contactor for controlling vacuum operations; chlorine residual recorder; portable direct current recorder for use in milliampere range; amperometric titrator for electrically indicating end point. Pressure gauges, dial manometers, aneroid barometers, absolute pressure indicators, mercurial barometers.

In Attendance: Warren F. Haring, Sales Mgr.; L. E. Demler, Sales Engr.; Frank A. Martin, District Manager.

W. M. Welch Scientific Co., Chicago, Ill. 241

Exhibiting: New Magnephot Densichron, a super-sensitive exposure meter and densitometer. Vacuum pumps, balances and electrical measuring instruments.

In Attendance: Raymond Hoffman, Charles Williams.

Weston Electrical Instrument Corp., Newark, N. J. 130, 132

Exhibiting: New Model 633 Clamp Volt-Ammeter combines in one instrument three a-c voltage ranges and five a-c current ranges; new Model 856 hermetically sealed photoelectric cell. Electrically indicating instruments and their accessories.

In Attendance: R. T. Pierce, Mgr. Process Industry Sales.

Wheelco Instruments Co., Chicago, Ill. 126, 128

Exhibiting: New Multi Switch Capacitrol with large "Distant View" scale provides up to 6 different types of control functions; new Model 1300 Flame-otrol combustion safeguard for gas and oil fired equipment; new De Luxe Chronotrol Capacitrol indicating and controlling pyrometer designed to conform to a preset heating and cooling time cycle; new Resistance Thermometer will accurately measure and indicate temperature from minus 300° to plus 1000°F; new Capacilog Strip Chart Recorder. Pyrometers, pyrometer controllers, strip chart recorders, input control, high limit control, portable pyrometers and potentiometers, tin content indicator.

In Attendance: F. Hansen, Pres.; Chas. L. Saunders, Exec. V. P.; C. A. Gates, V. P. & Eastern Div. Mgr.; R. A. Schoenfeld, V. P. & Western Div. Mgr.; B. Ramthun, Application Engr.; H. W. Bluethe, Adv. Mgr.; J. C. Freyberg, Asst. Adv. Mgr.; H. Proske, N. Y. Sales; J. P. Cantor, Cleveland Sales; J. E. Anderson, Indianapolis Sales; R. P. Campbell, St. Louis Sales; Leo Burnett & G. Burnett, Kansas City Sales; Don Walley, Chicago Sales.

Wilson Mechanical Instrument Company, New York, N. Y. 527

Exhibiting: "Rockwell" Hardness Tester for testing all metals, hard, soft, ferrous, non ferrous, also plastics. "Rockwell" Superficial Hardness Tester for testing of thin material; "Tukon" Tester for micro-hardness testing.

In Attendance: V. E. Lysaght, J. L. Kavalaris.

Yarnell Waring Company, Philadelphia, Pa. 207

Exhibiting: New Yarway Remote Liquid Level Recorder in a transparent plastic model, Yarway Remote Liquid Level Indicator; Flat Glass Water Level.

In Attendance: J. Frank Long, St. Louis Sales Representative; F. C. Harry Vaughan, Chicago Sales Representative.

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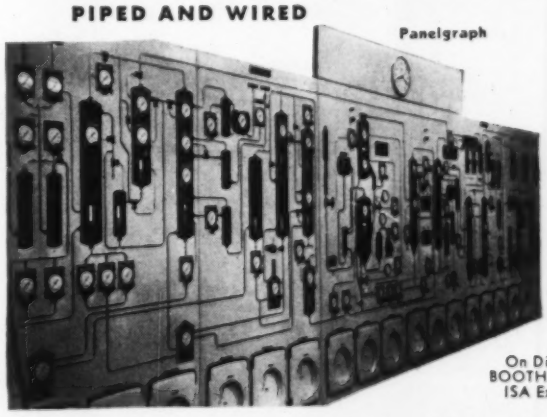

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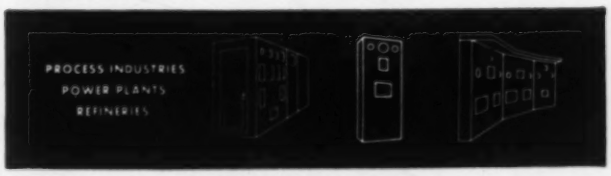

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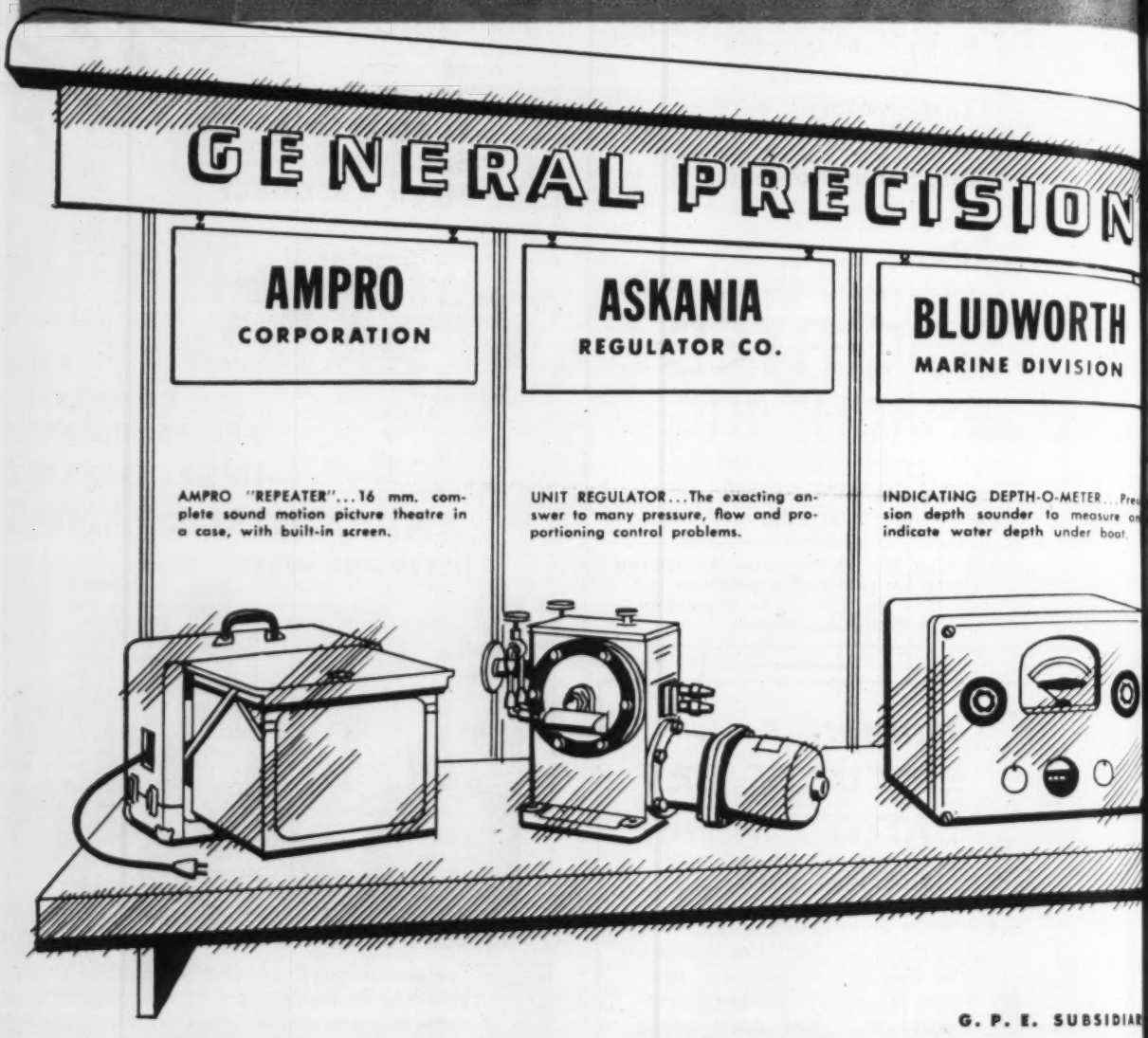
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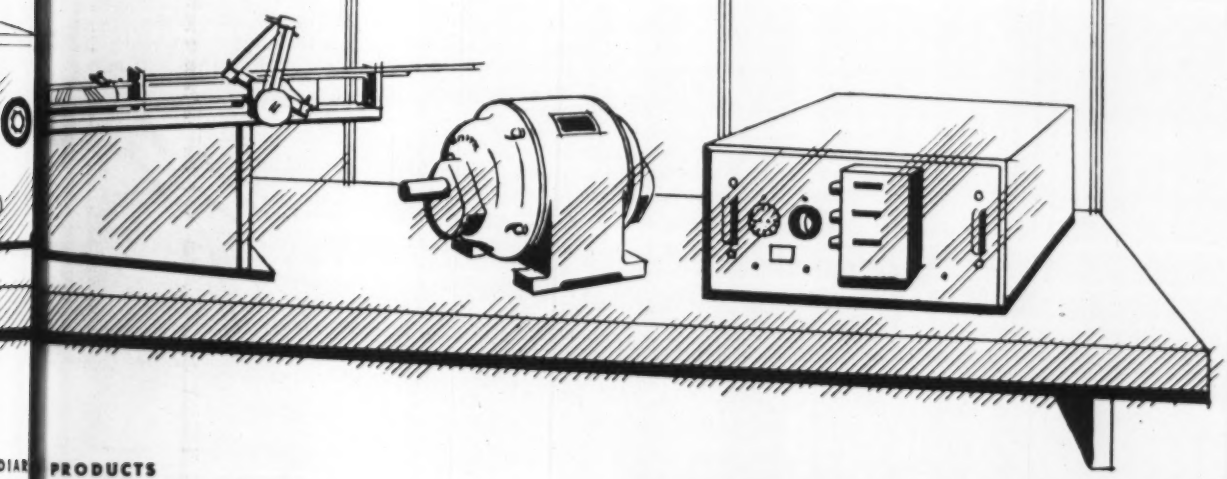

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The Month's NEW INSTRUMENTS

In this department we report each month new devices for measurement, inspection, testing, metering and automatic control — in the form of concise technical descriptions.

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High-speed Pressure Pick-up and Engine-indicating System

New Engine Pressure Indicating System consists of three units: pressure pick-up; amplifier and power supply unit; standard oscilloscope. Pressure pick-up utilizes a catenary diaphragm of negligible inertia actuating a tubular-form elastic member on which strain-gage wires for force measurement are wound in a novel arrangement which minimizes inductance and compensates for temperature changes. New pick-up's linear response to frequencies from zero to 20,000 cps. makes it suitable for both static and dynamic pressure measurements in test engines, detonation studies, chemical reactions at high pressures and temperatures, etc. Electrical signal lends itself well to telemetering applications. With low-pressure air cooling of pick-up, 1 percent accuracy is obtained from minus 10 to 2000 psi. up to 20,000 cps. Static pressures to over 3000 psi. can be measured, and calibration can be checked by deadweight test. Amplifier Power Supply unit receives output of pick-up and supplies a signal that may be fed into a standard oscilloscope for graphical presentation of pressure-time curve. Calibration of 'scope trace is obtained by actuating a panel switch, which provides standard reference voltages corresponding to known values of pressure as read on a directly-calibrated dial. Amplifier is battery-operated and entirely self-contained with space for cables, etc.—*Control Engineering Corp., Canton, Mass.*

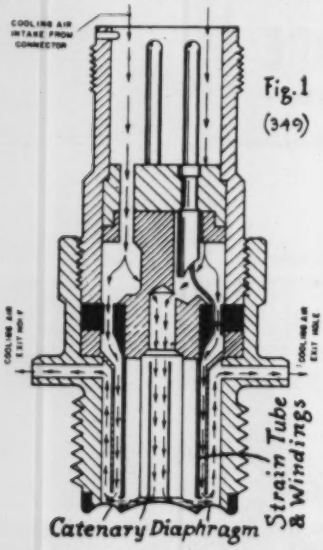
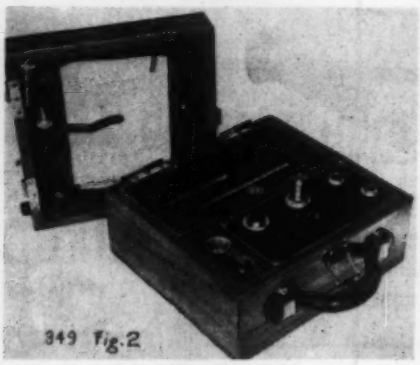


Fig. 1 (349)


349 Fig. 2

Mention No. 801 when filling out card.

Elastic Member With Negative Force-deflection Characteristic

New "Neg'ator" is a radically new type of prestressed coil component, describable as a spring-like device which works in reverse: the more it is deformed, the less it resists. In Fig. 1, curve A represents force-deflection characteristic of an ordinary extension spring wound with initial tension; B represents spring maker's attempt to approach designer's need for a zero gradient: never more than a crude approximation; D represents the flat characteristic of a "Neg'ator" prestressed for that purpose; and E represents the receding force-deflection characteristic of another "Neg'ator." In addition to this extraordinary negative force deflection characteristic, the "Neg'ator" has four other properties of significance to instrument engineers dealing with elastic elements and other components: (1) enormous expandability and range of action—up to 50 times any original dimensions; (2) ability to act around corners and through small openings with same freedom as non-elastic bands or cables; (3) high initial force in resisting first increments of deflection, and (4) ability to store and deliver approximately twice as much energy as an ordinary spiral or power spring occupying the same space. At this time the word "Neg'ator" represents an invention and a number of experimental devices rather than commercially-produced instrument components;

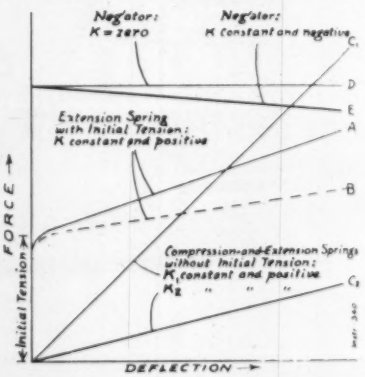


Fig. 1

Radiochemical Laboratories

New radiochemical laboratories include not only selected instruments and accessories made by undersigned manufacturer, but also selected instruments and equipment of other makes, thus affording the advantage of single responsibility. Illustration shows one laboratory which provides for all normal measurements, permits making many unusual experiments, and is said to permit making quantitative measurements more accurately, for a given length of time, than ever before. It comprises: (1) RCL Scaler, Higinbotham type; (2) Thin-wall jacketed counter; (3) Thin-wall dipping counter; (4) Miniature thin-wall counter; (5) Aluminum absorber set, calibrated; (6) Victoreen Minometer and one chamber; (7) Victoreen chambers; (8) Nucleometer, scaler type, with external sample counter; (9) Aluminum sample pans; (10) Internal sample counter; (11) Beckman Radiation Meter; (12) Mica window counter Survey Meter, a-c.-operated; (13) Stainless steel safety tray; (14) Micro-chemical glassware; (15) Iron bricks; (16) Sample tongs; (17) Sample spinner; (18) RCL dust-tight safety chamber. — *Radiation Counter Laboratories, Inc.*, 1844 *W. 21st St., Chicago 8, Ill.*

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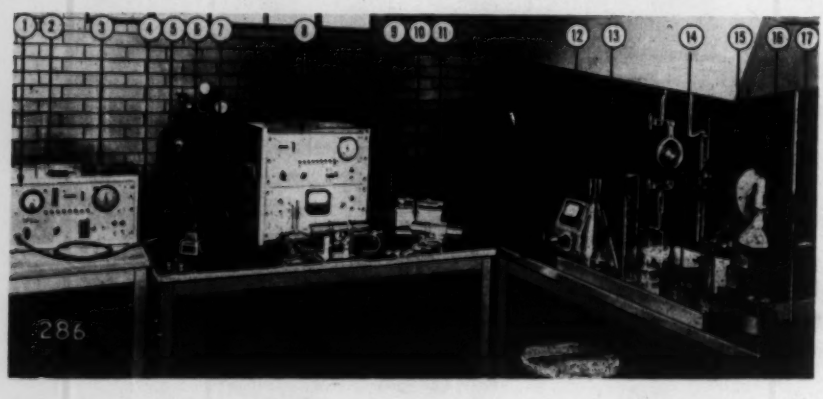
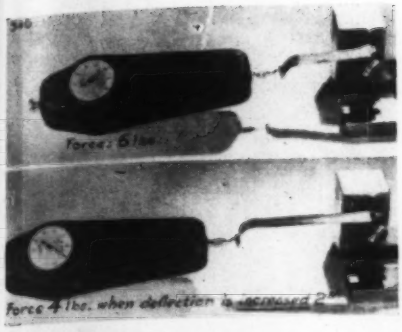


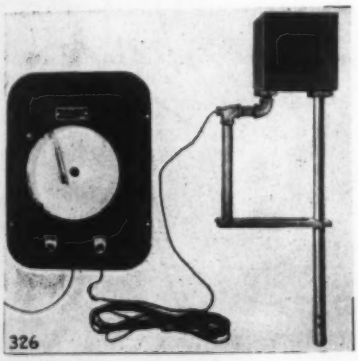


but already ten basic fields of usefulness have appeared: (1) as an extension or compression spring; (2) as a self-adjusting clamp; (3) clip; (4) wrapping; (5) precision force adjustment; (6) transducer or converter of energy from one form to another; (7) automatic coiling device; (8) friction band; (9) telescopic tube form; (10) means of transmitting power or motion. A technical article is being prepared exclusively for *Instruments* discussing some possible applications of No. 6: "Neg'ators" as measurement and automatic-control transducers.—*Neg'ator Division, Hunter Spring Co., Lansdale, Penna.*

Mention No. 803 when filling out card.

Continuous Viscometers for Industrial Process Control

New Recording Viscometers, specifically designed for industry, will continuously measure, record and, where desired, control viscosity of any solution under pressure, atmospheric pressure,



or vacuum in a tank. Can also be furnished in an explosion-proof design for hazardous applications. Viscosity is recorded on a 24-hour chart; an alarm system indicates when viscosity deviates beyond predetermined limits. Any desired viscosity range can be quickly and easily obtained. Particularly applicable to resins, varnishes, paint, oil, starch or synthetic solutions, petroleum, adhesives, syrup, and glue products. Equipment consists of (1) measuring element, installed in a vertical position with its lower end immersed in the liquid or solution whose viscosity is to be measured; can be made of any material with dimensions that are suitable for the proposed installation; (2) recorder, which can be mounted at any distance from measuring element. Viscometer can be operated on any 110-volt 60-cycle supply providing 2 amperes.—*Norcross Corp., 247 Newtonville Ave., Newton, Mass.*

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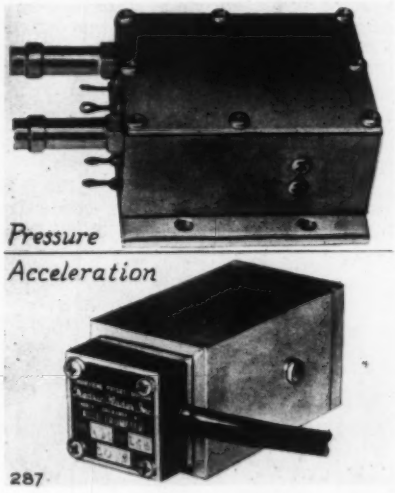
Electrical Accelerometers and Pressure Transmitters

New "Teleflight" miniature pick-ups for industrial use comprise acceleration and pressure units producing electrical output varying linearly with imposed acceleration or pressure. Output can be



used for remote indication, recording or control. Units employ a cantilever beam on which four active 300-ohm strain gages are bonded, two on either side of beam, forming four arms of Wheatstone bridge circuit for maximum output. Flexure of beam produces output of approximately 4 millivolts (open circuit) per volt input for full range. A maximum of 18 volts may be applied to bridge. Units are temperature-compensated for both zero shift and sensitivity to better than 0.01 percent per degree F. Greater compensation is available upon special request. Pressure transmitters are available in ranges up to 100 psi., differential gage or absolute; can be modified for use as airspeed indicators and altimeters; approximate dimensions 2 in. x 2 in. x 1.13 in.; weight approx. 4 oz. Accelerometer ranges available to 500 G; dimensions approximately 1 in. x 1 in. x 2 in.; weight between 4 and 8 oz. depending on range. Frequency response of all units, between 50 and 500 cps. depending on ranges. —*Frederick Flader, Inc., 583 Division St., North Tonawanda, N.Y.*

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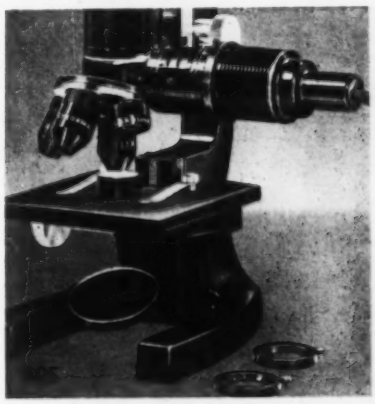
Triple-duty Microscope Attachment

New "Tri-vert Illuminator" is a microscope attachment that provides three types of reflected illumination: bright field, dark field, and polarized. It



can be readily attached to body tube of any standard mon-objective microscope for examination of opaque or semi-opaque specimens. Changeover from dark field to bright field illumination is

Adapters for Making Spectrographs Direct-reading

New "SQA Spectograph Quantometer Adapters" may readily be attached to spectographs already in use, converting them into direct-reading instruments. Owners of ARL spectographs can set up for direct reading analysis at minimum cost. In addition to basic circuits, new "SQA" contains all auxiliary circuits found to be successful in the original direct-reading "Quantometer."—*Applied Research Laboratories, 4336 San Fernando Road, Glendale 4, Calif.*

Mention No. 806 when filling out card.

Spark-Arc Source Unit

New "Spark-Arc Source Unit" (shown at right) provides routine control laboratory with a dual-purpose source: one source unit for precision analysis of elements at higher concentrations; a second for high-sensitivity trace analysis.—*Applied Research Laboratories, 4336 San Fernando Road, Glendale 4, Calif.*

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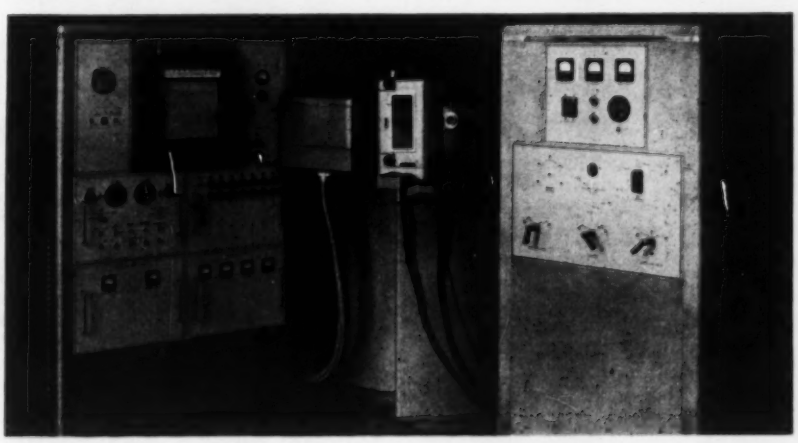

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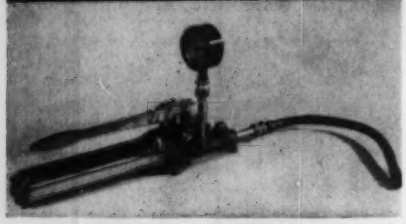
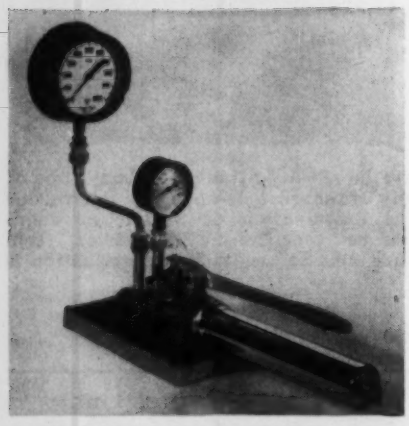


*1 PORTABLE PRESSURE TESTING for Weight, filled with oil, 8½ lbs.



*2 BENCH WORK WITH TEST GAGE for mounted on aluminum drip pan

*3 DEAD WEIGHT TESTING for shown with dead weight attachment mounted on unit.
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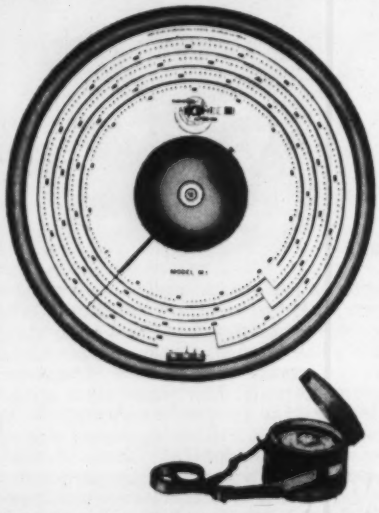
instantaneous and is controlled by a lever. A Polaroid polarizer and cap analyzer provide for polarized light examinations. Vertical illumination is attained by a glass reflector plate coated with titanium oxide. Periphery of plate is aluminized for dark field beam, clear center for bright field and polarized light. A quadruple revolving nosepiece is employed to accommodate four objectives, mounted in an illuminating cell of transparent plastic.—*Bausch & Lomb Optical Co., Rochester 2, N.Y.*

Mention No. 808 when filling out card.

Micro-surveying Altimeter

New "Model M-1," said to be the first micro-altimeter ever made, is graduated in intervals of one-foot over a range of

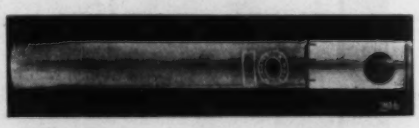


6,000 feet, is accurate to one foot and sensitive to altitude changes in inches. It is said to permit geologists, surveyors and field engineers to run surveys in one-tenth the time consumed in ordinary surveys and with "accuracy and dependability hitherto unknown in this type of instrument work." Weight is 4.5 lbs. "Model M-5" has range of 15,000 feet graduated in intervals of five feet; "Model MM-1" has range of 5,000 meters, one-meter graduations. All models have leather carrying case with hand and shoulder straps; also a magnifier, thermometer and full operational procedures. — *American Paulin System, 1847 So. Flower St., Los Angeles 15, Calif.*

Mention No. 809 when filling out card.

Neutron Counters

New "Enriched" BF_3 Neutron counters are of brass in various sizes from 1 to 2 in. diameter and from 6 to 24 in.



long. The 1½ x 12 in. counter filled at 45 cm. operates at about 2400 volts, has well over 200 volt plateau with less than 5% slope. Efficiency is more than four times that of the normal BF_3 counter since the boron is 96% boron-10.—*N. Wood Counter Laboratory, 5646 Harper Ave., Chicago 37, Illinois.*

Mention No. 810 when filling out card.

Moisture Meter for Lumber

New "Model DC-1" for testing moisture content in lumber is said to be the smallest instrument of its kind ever

produced commercially (3.75 in. x 5 in.); weighs less than two pounds. It utilizes megohm bridge principle, covers range from 8% to 29%. Tests inside kilns are accurate down to 4% at kiln temperatures. For most woods, moisture may be read directly from the dial. In addition, easy-to-read calibration tables are furnished for 35 woods. Condensed tables are printed on instrument shell; complete tables are supplied in booklet form. Standard-type miniature batteries and tube are said to give long service. —*Moisture Register Co., 133 North Garfield Avenue, Alhambra, Calif.*

Mention No. 811 when filling out card.

Exposure Photometer

New "Model 200-M Exposure Photometer," for exposure determination in photomicrography and metallography, is a photoelectric instrument which measures intensity of light at ocular of

microscope and indicates this intensity on the scale of a sensitive indicating galvanometer. A calculator is offered as an accessory to translate readings into exposure time. Instrument is suitable for black-and-white as well as color photomicrography. Its sensitivity is sufficient for timing of photomicrographs at magnification ratios which call for exposure times as long as 10 minutes. For measurements of light on ground glass, two of maker's "Electronic Photometers" are offered which per-

mit measurements to be taken on small areas of ground glass image. These photometers operate with phototubes and electronic amplification. For highest sensitivity, one of these photometers can be furnished with a photomultiplier in lieu of standard phototube. New instruments are also recommended for color measurements on stained tissue sections and for evaluation of fluorescence phenomena on microscopic slides. A 22-page Technical Information Bulletin is furnished with each instrument. —*Photovolt Corp., 95 Madison Ave., New York 16, N.Y.*

Mention No. 812 when filling out card.

Blue-screen CRO Tube for Photographic Recording

New "3KP11" three-inch blue-screen oscillograph tube permits owners of maker's "WO-79A" and similar oscilloscopes using the "3KP1" tube to increase versatility of these instruments for photographing electrical phenomena. Its fluorescent screen's blue radiation is highly actinic and has sufficiently short persistence for recording on moving film without blurring, except where the film moves at high speed. New tube is also satisfactory for visual observation: improved phosphor has unusually high brightness.—*Commercial Engineering, RCA Tube Dep't, Harrison, N.J.*

Mention No. 813 when filling out card.

Test Head for Metals Comparator

New test head for maker's "Metals Comparator" is for use on flat surfaces, particularly of large equipment, where the conventional test coil is inapplicable.

Contact face of new head consists of a ring separated from a concentric core by an air gap, thereby forming a radial magnetic path across which test piece is placed. It is 3 in. long and can be supplied in various face diameters depending upon application. — *General Electric Co., Schenectady 5, N.Y.*

Mention No. 814 when filling out card.

Klystron Power Supply

New "Model 910 Klystron Power Supply" delivers all voltages and currents for the operation of a high-power klystron; comprises four units: (1) beam supply; (2) reflector supply; (3) control electrode supply; (4) filament supply. First three units delivering d-c. power are well regulated; fourth unit delivering a-c. power is not regulated. Four units are so interconnected that beam power supply, reflector supply,

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Directly measures surface roughness in microinches r.m.s. on machined, ground and finished surfaces, external and internal, from $\frac{1}{32}$" to several feet in length. A basic shop tool for quality control, and an accepted aid to production economy.

ANDEROMETER*

Gives an over-all quality rating of assembled ball bearings in production or receiving inspection. Permits *numerical specification of ball bearing quality*, and provides control of production operations.

WAVOMETER*

Measures the microinch *waviness* (r.m.s. average) of internal and external surfaces of rotation such as bearing races. Permits *numerical specification of waviness*, and gives close control of production set-ups.

PROFICORDER*

Records a magnified *true profile* of machined and other surfaces, showing *shape*, *height* and *spacing* of waves, bows, steps, roughness and other surface irregularities. Opens new possibilities in production set-up and inspection, in quality control, and in technical research.

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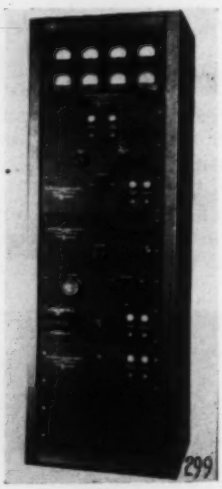
and control electrode supply are normally operated at a high negative voltage with respect to metal enclosure. Power Supply has been built in four sections to facilitate construction and maintenance. Above-mentioned units are dis-

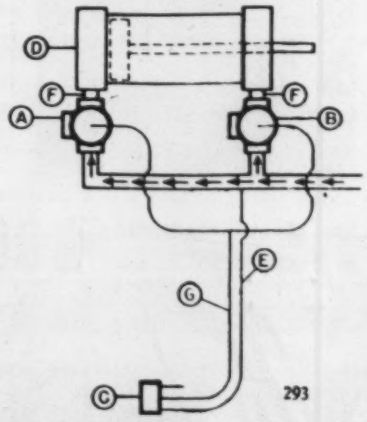


tributed among these sections as follows: Top section contains all voltage and current indicators—one each for each of the four units. Section II contains reflector supply unit, control electrode supply unit, also two main switches, main fuses, etc. Section III contains filament supply, part of beam supply unit, etc. Section IV (bottom) contains remainder of beam supply unit, also a time delay relay which delays application of high voltage to rectifier tubes and load. Connections of input circuits of all sections are made in such a manner that no high voltage appears on output receptacle if any section is removed from cabinet.—*Furst Electronics, 12 S. Jefferson St., Chicago 6, Ill.*

Mention No. 815 when filling out card.

Three-way Pneumatic Valve

New "Full-Flo" master valve makes possible a new type of valve installation. Instead of conventional mounting of a 4-way valve at some distance from cylinder, new method places 3-way valves (A & B), one normally-open and one

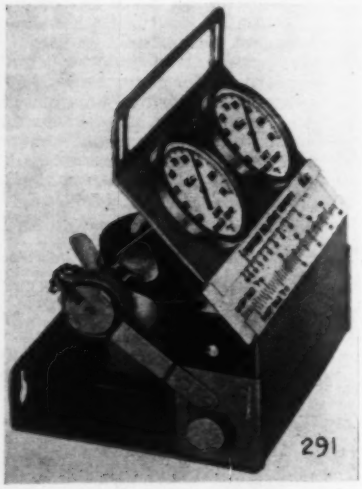


normally-closed, at each end of cylinder D. Operation is effected by conveniently located small pilot valve C, which can be manually, mechanically or electrically actuated. Thus, long lengths of large-diameter pipe between valve and cylinder, which had to be filled and exhausted with non-productive air, are replaced by short connecting lengths F. Air supply is received by pilot valve and dispatched to master by means of tubing (E & G). Saving in air with every movement of piston lowers operating costs. New master valve is available in ¼-inch through 1¼-inch, straightway or 4-way, normally open or closed. For short-stroke, double-acting cylinders, 4-way master units can be supplied.—*Ross Operating Valve Co., 120 E. Golden Gate, Detroit 3, Mich.*

Mention No. 816 when filling out card.

Fan Attachment for Humidity Indicator

New motor-operated fan for attaching to maker's Relative Humidity Indicator permits accurate humidity readings to be obtained quickly in shops, rooms and even small confined spaces

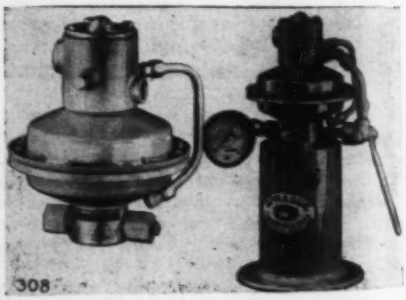


near or in operating machinery. Powered by dry cells, fan will move air over indicator's wick in sufficient volume to permit obtaining stable readings within 30 seconds. No calculations are required, as readings are immediately obtained on the instrument's simplified slide rule.—*Weston Electrical Instrument Corp., 617 Frelinghuysen Avenue, Newark 5, N.J.*

Mention No. 817 when filling out card.

Hydraulic Boost Pump and Power Unit

New high-pressure hydraulic boost pump operates on 100 psi. plant air supply; provides hydraulic pressures



from 1,000 to 30,000 psi.; is suitable for oil or water service; measures 8 in. O.D., 10 in. high, weighs 20 lbs. Power unit,

AT LAST! 6-Point Recording on a Single Round Chart

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Employing only one measuring system, the new Foxboro Multi-Record Dynalog gives up to 6 clean-cut records in as many different colors on one convenient *round* chart. The ingenious, foolproof switching arrangement provides recordings in sequence every 6 seconds—so close that the record of each measurement appears as a continuous line. The record colors positively will not run together.

Like all Dynalog Electronic Instruments, balancing from any measurement point is entirely *stepless* and continuous. Its combination of accuracy, speed and sensitivity is unequalled.

The Multi-Record Dynalog is available for measuring several temperatures or other process variables. Send for Bulletin 428. **The Foxboro Company, 46 Neponset Avenue, Foxboro, Mass., U. S. A.**

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1. Round Chart simplifies operations. You can check records faster, easier and better on the familiar, compact round chart of the new Multi-Record Dynalog. No yards of paper to insert, remove and spread out. Practically continuous lines to follow. Up to 6 distinct colors. Charts occupy less space . . . cost less to use.

2. Round Chart standardizes operations. You can order, stock and use the identical form of chart as used on other types of process instruments.

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"Model C-R" (shown at right) includes pump, is supplied complete, ready for installation with reservoir, pressure gage and necessary control valves. —*Sprague Engineering & Sales, Gardena, Calif.*

Mention No. 818 when filling out card.

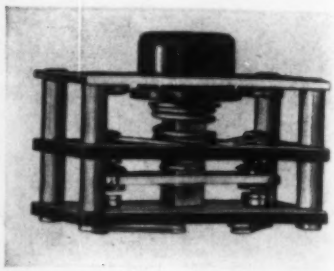
Voltage Divider

New laboratory model "Helipot" is said to be an ideal resistance unit combining wide range of maker's 10-turn "Helipot" with precision adjustability of maker's "Duodial" instrument. It is principally recommended for incorporation in temporary circuits and for checking test instruments. It has special binding posts which facilitate rapid connection into circuit assemblies. Available in wide variety of stock values.—*Helipot Corp., South Pasadena, Calif.*

Mention No. 819 when filling out card.

Momentary-contact Push-button Switch

New "No. 5860" momentary-co act non-shorting s-p. d-t. push-b ton switch, originally designed for a ter



testing circuit, suits other applications of a similar nature. Pressing push-button opens closed circuit and then closes open circuit as long as pressure is applied. A heavy positive-action spring on push-button avoids possibility of acci-

Contour-following System

New contour-following system follows the lines of a drawing with an electric eye and guides a machine tool to cut out metal parts according to the drawing. It was designed to simplify manufacture of irregularly-shaped metal parts. It is capable of following a line in the form of a closed loop with a diameter as small as 0.06 in. It scans drawn line through a low-power microscope at a speed up to 6 in. per minute. When line is in center of microscope's field, electric eye sends out a 60-cps. electrical signal. A 26-tube electronic circuit picks up this signal. If line is not in center of field, phasing varies and circuit instantly commands mechanical guides to bring electric eye and microscope back into position. Instrument does not vary from drawn line by more than 0.003 in. Microscope and electric eye are placed on a movable mount which rests on a lathe bed. Drawing is set a fraction of an inch from the microscope on another movable mount. When drawn line travels to left or right, microscope-and-eye move to follow it. When line travels up or down, drawing itself changes position. These motions electrically command controls on machine-tool slave unit. A set of change gears provides reduction ratios between drawing and finished part from 3.75-1 to 60-1. Thus, relative dimensions of one basic shape can be distorted in two dimensions by small incremental alterations on control panel. Also, because of this range of reduction ratios, error in finished piece cut by slave unit is said to be less than 0.001 in. Equipment requires 220 volts, 60 cycle, approx. 20 amps.; will perform satisfactorily at ambient temperatures 65 to 104 F.—*Special Products Div., General Electric Co., Schenectady 5, N.Y.*

Mention No. 820 when filling out card.

ental pressure operating the switch. Quarter-inch-diameter silver contacts ave a contact resistance of less than 002 ohm. A potential as high as 3,000 olts d.c. may be applied across normal-y-open contacts without arcing. Switch s 2 in. long x 1 in. wide x 1½ in. deep xclusive of push-button and may be ounted by means of two screws. —*Shallcross Mfg. Co., Collingdale, Pa.*

Mention No. 821 when filling out card.

Laboratory Standard Type Communications Receiver

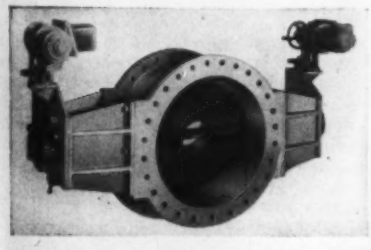
New "Type 51J-1" radio communications receiver is a double-conversion superheterodyne, continuously tunable over frequency range of 0.5 to 30.5 Mc. Its stability and tuning accuracy are

said to be such as to commend its use as a secondary frequency standard. Tuning range is divided into 30 bands of 1,000 kc. each. Under normal operating conditions and with a 10-minute warm-up period, dial reading is within two kc. of receiver's exact frequency throughout frequency range. A movable fiducial is provided so that dial may be set to exact operating frequency of receiver. Tuning mechanism is free from backlash. Receiver frequency over temperature range minus 20 C. to plus 60 C. does not vary from frequency at 20 C. by more than 30 parts per million plus 1 kc.; thus frequency stability is within 2 kc. at highest operating frequency. Receiver frequency does not vary more than 100 cps. from frequency at 115 volts when line voltage is varied from 105 to 125. Changes in atmospheric pressure from sea-level to 10,000 feet altitude, relative humidity from 10 to 90 percent, and mild shock, do not vary receiver frequency by more than 500 cps.—*Collins Radio Co., Cedar Rapids, Iowa.*

Mention No. 822 when filling out card.

Motor-driven Dual Valve

New "Type No. 725" is a 36-inch by 8-inch 150-pound Class B steel dual valve for an operating temperature of 1000 F. Body casting is chrome-moly



steel. Powered by separate electric motors, alloy steel vanes are operated each independently of the other, insuring close control of volume and pressure. Valve is designed for either a high pressure drop and small volume or a low

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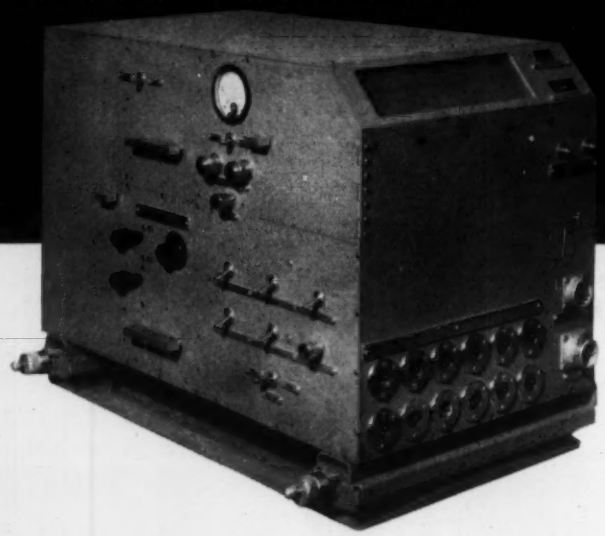

FEATURES

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4. Timing System — Discharge lamp controlled by temperature compensated tuning fork providing sharp .01 second with heavier .1 second timing lines. Conversion to .1 second lines only, by switching.
5. Independent optical system provides constant view of traces with optimum light intensity at all times.
6. Recording lamp under constant surveillance of external condition indicator lamps.
7. Galvanometers — with optional range of frequencies and sensitivities.
8. Electrical — Available for operation from option of 12 or 24 volts D.C., or 110 volts A.C.

OPTIONAL FEATURES

1. Trace identification by means of light interruption.
2. Trace scanning for observation of steady state phenomena.
3. Remote control unit.
4. Automatic record numbering system.
5. Automatic record length control.
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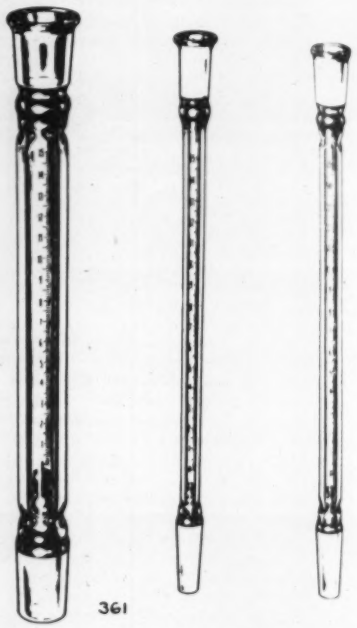
pressure drop and large volume, thus operating beyond the limitations of a single valve. Available in all materials in various combination of sizes and for higher pressures.—*R-S Products Corp., Wayne Junction, Philadelphia* 44, *Pa.*

Mention No. 823 when filling out card.

Laboratory Rotameter

New set of rotameters is said to answer practically all laboratory needs for accurate and convenient measurement of flow rates. Three instruments, each one containing a glass and a stainless steel ball, cover a range of air flow



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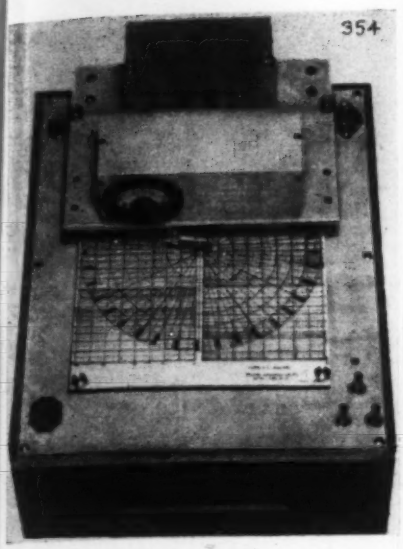
from 3 to 110,000 cc/min. and a range of water flow from 0.064 to 3,800 cc/min. Instruments with a single glass ball also are available. Each instrument is supplied with a ground glass male and female outlet so that all glass connections may be made as well as conventional rubber tube connections. Instruments are supplied with calibration curves for air and water and correction charts for all other gases and non-viscous liquids. —*Emil Greiner Co.*, 20-26 *N. Moore St., New York* 13, *N.Y.*

Mention No. 824 when filling out card.

Polar Recording Instrument

New "Model PFR Polinear Recorder" is said to offer for the first time means of recording complete characteristics of electro-acoustic and electronic devices in one instrument. Combined features of polar and rectilinear movement permit recording angular patterns, frequency-response characteristics, etc. Instrument can record d-c. or a-c. voltages, selectable by operator. Turntable, $8\frac{1}{2}$ in. x 11 in., is driven linearly by a synchronous motor and is rotated by a Selsyn repeater. (Repeater allows test turntable to be placed at any distance from recorder.) Turntable of recorder is equipped with a friction slip clutch which allows operator to set it at any angular position independently of Selsyn position, or any linear position independently of drive motor. Both linear

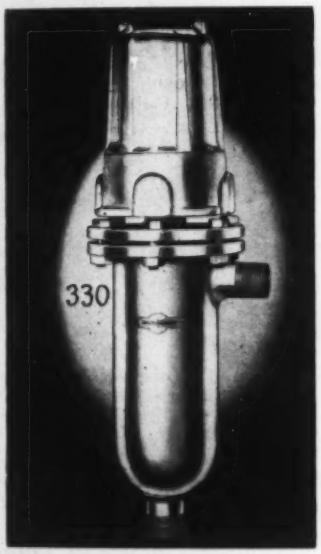


and polar motions are reversible. Special combination charts, polar and semi-log., are available; standard commercial charts of polar or semi-log type can also be used on this recorder. Carrying case dimensions, 11 in. x 13 in. x 17 in. —*Sound Apparatus Co., Stirling, N.J.*

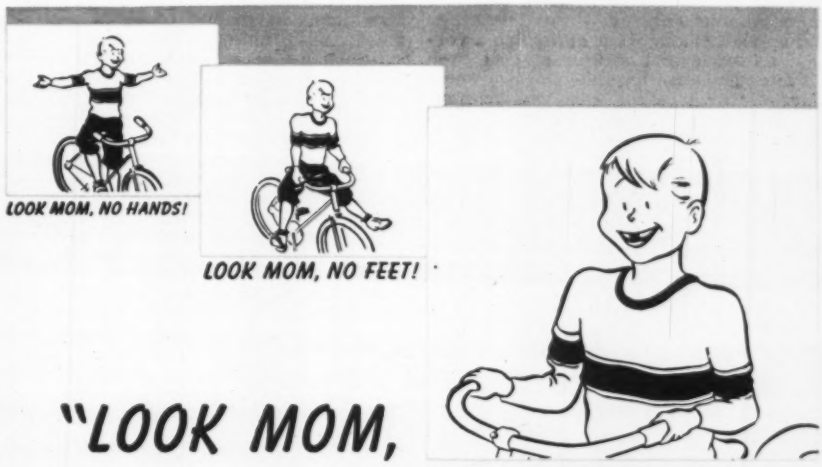
Mention No. 825 when filling out card.

Magnetic Proximity Float Switch

New "Type H" liquid level control, designed for heavy-duty industrial service, has no conventional packing boxes, bellows, or diaphragms. Various models have standard or explosion-proof cover,



forged steel body, stainless steel float, and non-corrosive switch unit; for internal pressure ranges from vacuum to 600 psi. and temperatures to 700 F. Higher pressure controls made to order. Units are suitable for use with liquids of 0.55 specific gravity and upwards. Units for below 0.55 s.g. made to order. Anti-corrosion materials can be supplied. Key components are "Magneswitch" s-p. d-t. proximity switches using Alnico permanent-magnet elements, housed in simple metal cannisters, with no mechanical connection to float. In two-switch applications, cannisters are



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"... The gages specified on the above order are to replace standard clock gear movement type now in use to indicate pressures in several of our chemical processes which are subject to considerable pulsation. From previous experience the writer has found the Helicoid movement to be far superior to the old type."

Signed by a Plant Superintendent.
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Of course they have to be dependably accurate—long-lasting—easy to calibrate. Those are the advantages that add up to lower cost per gage, per year. And the more gages you use, the more substantial the saving.

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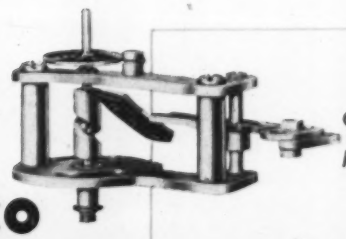

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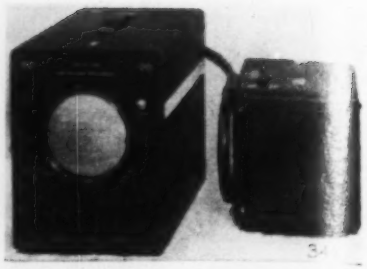
mounted one slightly above the other and opposite each other alongside a vertical non-magnetic stainless steel tube in which float rod ascends and descends. Magnetic armature is attached to float rod with a differential connection that allows for a small movement of float to prevent false action due to turbulence. —*Jo-Bell Products, Inc., 4840 So. St. Louis Ave., Chicago, Ill.*

Mention No. 826 when filling out card.

Low-frequency Cathode-ray Oscilloscope

New low-frequency cathode-ray oscilloscope with optional recording camera, developed primarily for measurements in sub-audible frequency range, has adequate h-f. response to handle all significant harmonics of this frequency band; is suitable for vibration studies, strain-gage measurements, servomechanism development, electrophysiological research, etc. Five-inch tube has long-delay screen. Fixed sweep speeds of 1, 2, and 4 inches per second are provided on time base, which may be either continuously-recurring or externally-triggered single-sweep. On the recording model a continuous 35-mm. photographic record may be made with internal camera which photographs spot through back of c-r.t. bulb. A single control on front panel operates camera, and vertical motion of spot can be fully observed on screen while record is being made. Accurate timing and amplitude markers may be printed on film by camera while trace is recorded. Daylight-loading camera holds 100 feet of



film per loading; receiving cassette up to 20 feet of record. Paper or film may be used, depending on speed of traces to be recorded. Vertical (Y) 4-tube differential-amplifier has high sensitivity (300 microvolts/inch); differential feature allows it to be used in high hum fields or when an undesired signal to ground exists on the two push-pull input terminals; its response is flat (3 db) from 0.04 cps. to 1200 cps. A single-ended connection provided into last two stages of amplifier gives d-c. response at a maximum sensitivity of 50 millivolts per inch. Equipment comprises two units, each weighing roughly 25 lbs.: Visual Unit (including camera) and Power Supply Unit, also 6-ft. interconnecting cable.—*Special Products Division, Smith & Stone Ltd., Georgetown, Ontario, Canada.*

Mention No. 827 when filling out card.

Spectrophotometer

New "Model 6B Junior Spectrophotometer" is for determination of oil color by Tentative Method recently adopted by American Oil Chemists Society; and

each instrument is specifically calibrated in accordance with recommendations and requirements. Available for immediate shipment.—*Coleman Instruments, Inc., 318 Madison St., Maywood, Ill.*

Mention No. 828 when filling out card.

Gamma-ray Detection Tube

New "GG306" gamma-ray detection tube, said to be five to six times more sensitive than standard tubes now used for tracing medicinal isotopes, analytical chemistry, thickness gages, geophysical studies industrial control and radiation survey meters, has been developed in cooperation with leading medical authorities. New tube is 6 in. long and 2 in. in diam.; radiations from isotopes may be measured with this tube several inches from patient's body. Increased sensitivity permits effective dosage with lower concentration of tracer isotopes. New tube is more directional than

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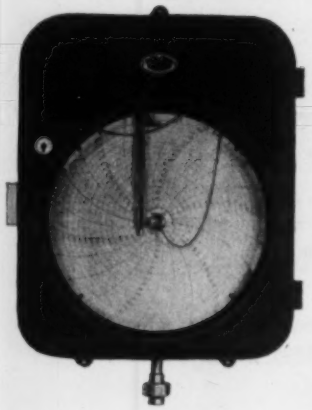

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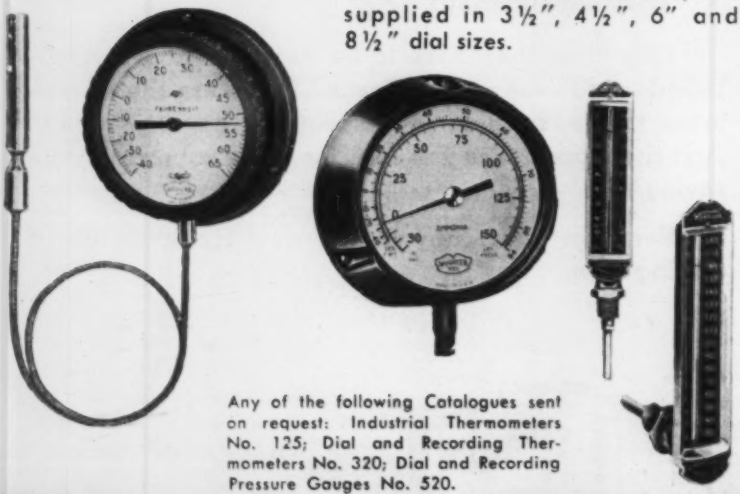

Any of the following Catalogues sent on request: Industrial Thermometers No. 125; Dial and Recording Thermometers No. 320; Dial and Recording Pressure Gauges No. 520.

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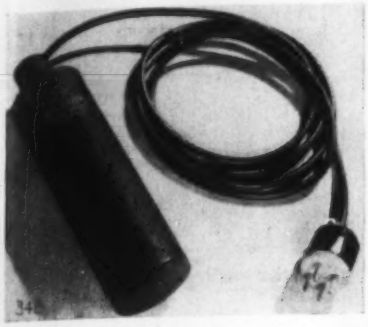
amma tubes hitherto available; is self-quenching; operates at 960 volts; has an average Geiger threshold of 900 volts; provides 810 counts per minute from 5 micrograms of radium filtered through

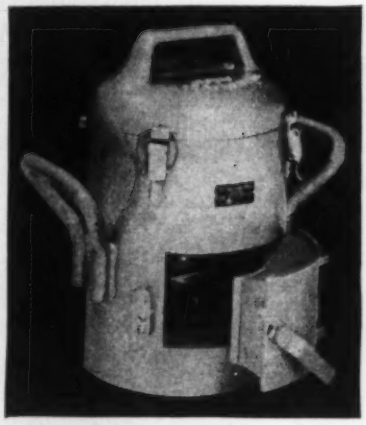


0.12 in. of lead 12 in. from end; has a maximum recovery time of 800 microseconds; maximum dead time of 100 microseconds; is suitable for an input circuit impedance of 5 megohms; and has an ambient temperature rating of —40 C. to 70 C.—*Electronics Div., Sylvania Electric Products Inc., 500 Fifth Ave., New York 18, N.Y.*

Mention No. 829 when filling out card.

Radiation Shield

New "Model 800" vertical lead shield is steel-cased, aluminum-lined and offers at least 1.5 in. equivalent of lead shielding in all directions. Top is of an improved aluminum and lead construction and, while readily removable, can be securely locked. Interior is equipped with a Lucite holder and is specially designed to be completely light-proof and background-proof. Dimensions: Inside, 5 in. diam. by 8.5 in. high; outside, 9 in. diam. by 14.5 in. high; door opening, 3.62 in. by 4 in.; weight, 250 lbs. —*Atomic Instrument Co., 160 Charles Street, Boston, Mass.*



Mention No. 830 when filling out card.

Timer Thermostat

New "T-70 Timer-Thermostat" provides remote control of day and night temperature periods, can be used in connection with heaters or furnaces equipped with automatic control systems. Responds to radiant or convective heat since metal cover is integral part of thermal element. Two models: one providing external day and night settings and the other providing external day setting and internally adjustable night setting. Stainless metal cover ex-

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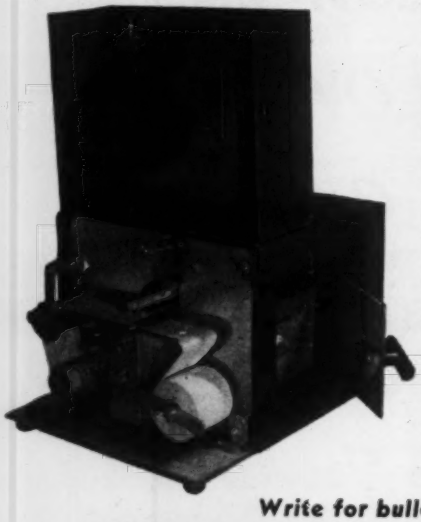
Operates on the output of a photo-electric cell, limit switch or any similar device. Records production against time and maintains a permanent record on a 2¼" tape. Automatically resets to zero every hour.



Here is a step in production counting that permits a complete analysis of efficiency in terms of hours or minutes instead of shifts, days or weeks. The reset feature eliminates much computation. It simplifies the entire task of studying production flow and determining how to maintain a high production level. Applicable to many industries such as process, printing, textiles, etc.

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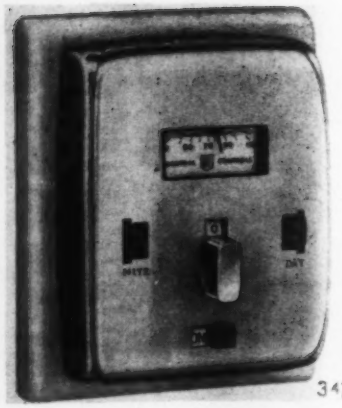
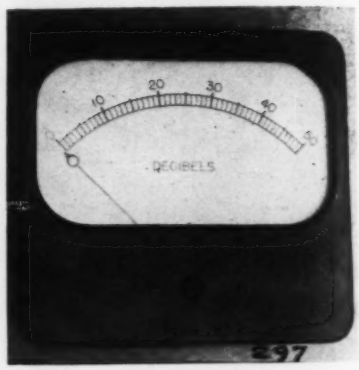


tends only 1½" from wall. Ivory base blends with any interior decorating scheme. Available as a single unit or within a packaged set of a complete automatic-control system. — *General Controls Co., 801 Allen Ave., Glendale 1, Calif.*

Mention No. 831 when filling out card.

Logarithmic Voltmeter

New "Model 121 Logger" has 50-db scales, reads both maximum and minimum program level on same range; measures system noise level in silent intervals of program. Feeding output (linear in db) to a direct-writing oscillograph (via suitable amplifier), it will record acoustical reverberation or efficiency of studio operators in riding

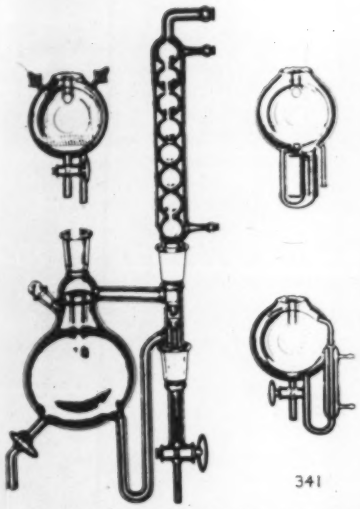


gain. In former application, Logger and generally available oscillographs will record as fast as 2500 db per second. Logarithmic operation uses new material operated with accurately stabilized bias. Action of material being instantaneous, frequency range is limited only by vacuum-tube circuits. Built-in VTVM has same operating speed as standard VU meter; for more rapid action log output may feed into a cathode-ray oscillograph. Unit includes preamplifier and power supply for log unit. —*Audio Instrument Co.*, 1947 *Broadway, New York* 23, *N. Y.*

Mention No. 832 when filling out card.

Othmer Still

New Othmer still is designed for determination of vapor-liquid equilibrium. Operation is based on reflex equilibrium principle. Vapors in equilibrium with boiling liquid mixture in boiler are completely condensed into a distillate trap and overflow from trap is refluxed to boiler. When composition and quan-



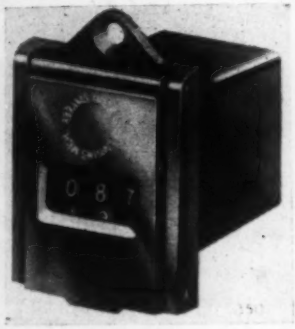
341

tity of vapor leaving boiler is exactly equal to composition and quantity of distillate returning to boiler, equilibrium is established and boiling point remains constant under total pressure imposed on systems. Samples of liquids in the boiler and trap are then removed for chemical or physical chemical analysis to determine compositions of the respective liquid and vapor phases in equilibrium.—*Emil Greiner Co.*, 20-26 *N. Moore St., New York* 13, *N.Y.*

Mention No. 833 when filling out card.

Magnetic Counter

New three- or four-digit precision counter, adaptable to industrial use, is one inch high and less than two inches deep, weighs two ounces. Additive or subtractive counter wheels register a maximum of 1,200 counts per minute. Figures are either white or fluorescent



on black. Each wheel can be reset manually. Actuated through electromagnets, these counters can be connected in vacuum-tube plate circuits, or can be operated by any contacting device. 24-volt d.c. or 110-volt d.c. coils are standard.—*Abrams Instrument Corporation, Lansing* 1, *Mich.*

Mention No. 834 when filling out card.

Solenoid Valves

New solenoid valves for air pressures of 0 to 125 psi. are available in 0.25, 0.375 and 0.5 in. sizes, spring return,

The Brush Single-Channel Oscillograph with Carrier Amplifier, Model BL-310. Oscillographs available in Double and Six-Channel units also.

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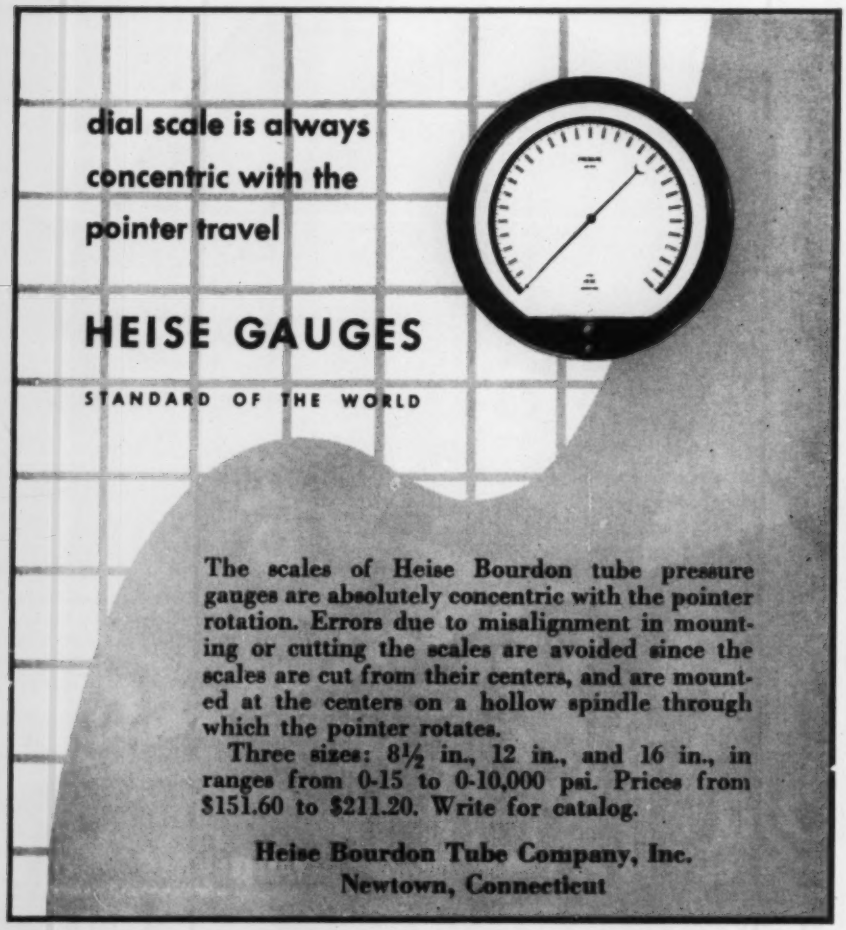

The scales of Heise Bourdon tube pressure gauges are absolutely concentric with the pointer rotation. Errors due to misalignment in mounting or cutting the scales are avoided since the scales are cut from their centers, and are mounted at the centers on a hollow spindle through which the pointer rotates.

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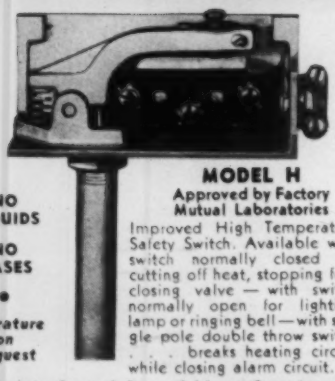

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Wood Testing Fixtures

New Wood-testing fixtures for ...tandard testing machines are desig...ed to meet latest ASTM specificatio... (D-143-49). They include those for ...transverse or static bending test (Fig. 1),

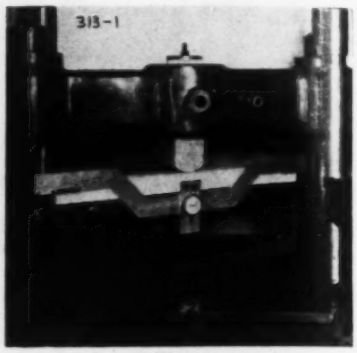


Fig. 1

tension parallel-to-grain (Fig. 2), cleavage (Fig. 3), hardness (Fig. 4), compression perpendicular-to-grain (Fig.

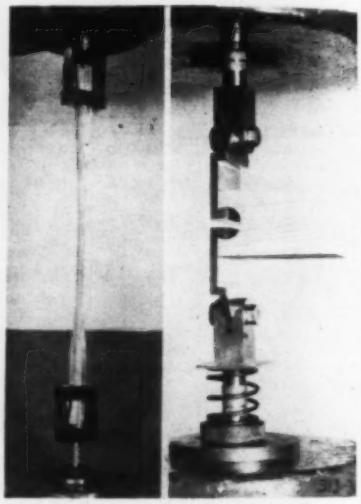


Fig. 2 Fig. 3

5), and shear parallel-to-grain (not illustrated). Crosshead pacing, which is specified for all of these tests, is provided by chain drive ram pacer, shown in Fig. 1 with bending test fixtures on maker's standard testing machine.—*Testing Equipment Dep't, The Baldwin Locomotive Works, Philadelphia* 42, *Pa.*

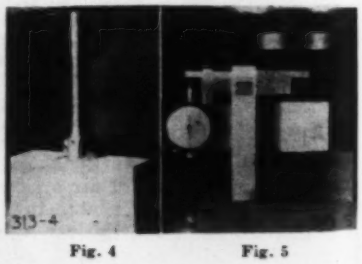
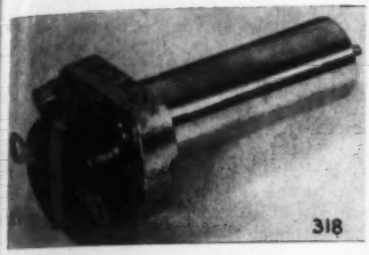


Fig. 4 Fig. 5

Mention No. 836 when filling out card.

Snap-action Thermostats

New "3-C 1200" liquid-expansion snap-action thermostats, originally developed for aircraft use (hence vibration-resistant) are suitable for motors,

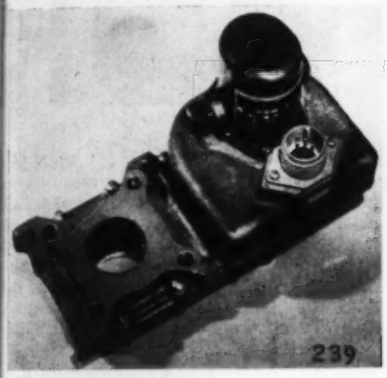


heaters, etc. Four-degree differential is said to be exceptionally close for snap-action thermostats. Available ranges (F.): 70-90, 90-110, 110-130, 130-150; others up to 300 F. on request. Unlimited undershoot, overshoot 20 degrees above set point; direct- and reverse-acting in one unit.—*Smith Control Instrument Corp.*, 1329 *Highland Ave., Needham 92, Mass.*

Mention No. 837 when filling out card.

Fuel Shut-off Valve

New "Model 6400" fuel shut-off valve is a motor-operated, 1.25-in. unit principally for use with aircraft fuel but



also is available in models for hydraulic oil and engine lubricating oil service. Valve is designed for actuation in less than one second for use with 18 to 30 volts d.c. Models are available for service at temperatures from room temperature to 500 F.—*Saval, Inc., 1915 East 61st St., Los Angeles 11, Calif.*

Mention No. 838 when filling out card.

Marker Generator

New "Type ST-5A" Marker Generator is designed for use in TV applications where an accurate source of markers is required to mark specific frequency locations on a tuned circuit response

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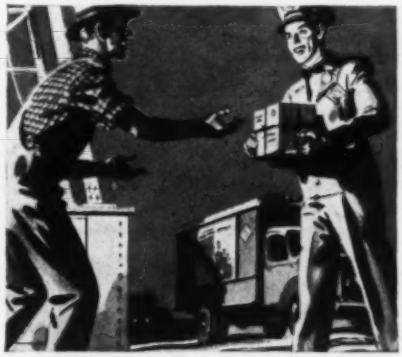
When a pump valve goes while drilling for oil, it's costly. Idle men and equipment make profits evaporate. It happened to a wildcatter at 4 P.M. Phoned 800 miles away for parts—delivered 11 P.M. that night by Air Express. 12 lbs. cost only $3.19. (*Regular* use of Air Express keeps *any* business moving.)



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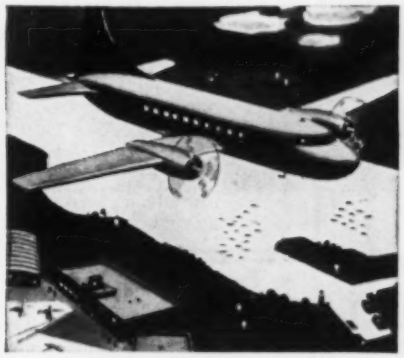

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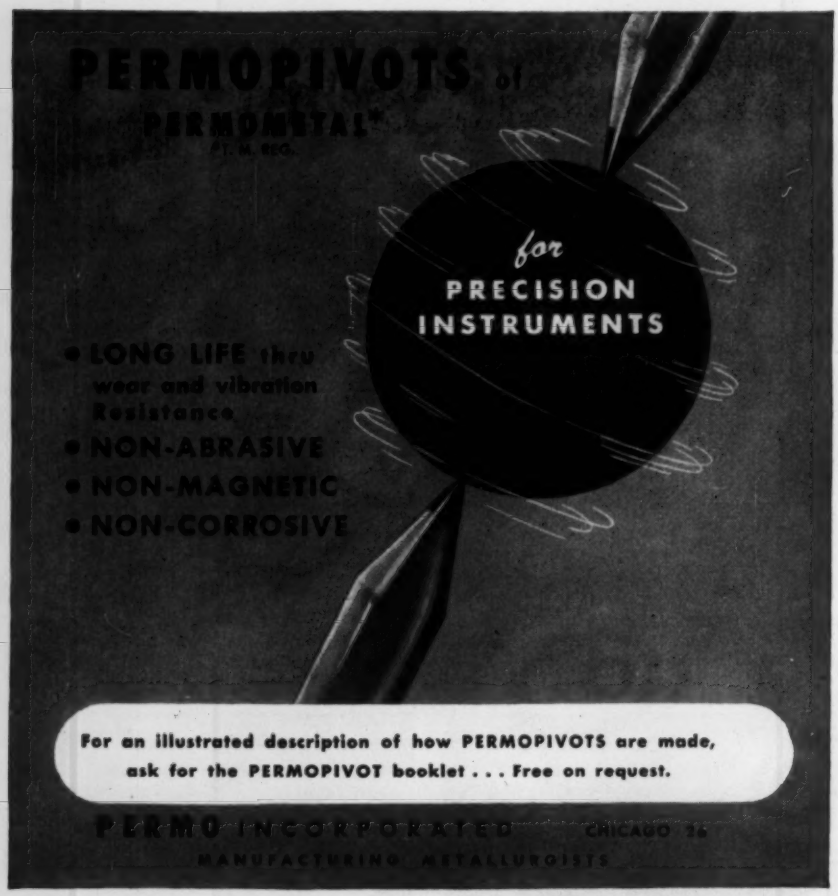
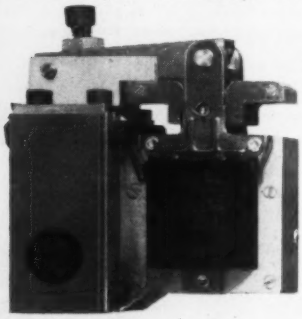


curve on CRO screen. A separate [illegible] for each TV channel is selectable by a rotary switch, with no tuning required. Picture and audio carrier markers are available simultaneously. From one to five markers may be used simultaneously, with complete freedom of positioning of markers in frequency range from 20 to 50 Mc. Only one dial setting is required for complete receiver alignment, and pass band and trap circuits can be aligned in one operation. There is no r-f. output, as markers are not passed through circuit under test. "ST-5A" weighs 37 lbs. in its case, and front panel is slotted for mounting in standard 19-inch relay rack.—*Specialty Division, General Electric Co., Electronics Park, Syracuse, N.Y.*

Mention No. 839 when filling out card.

High-pressure Continuous-duty Solenoid Valve

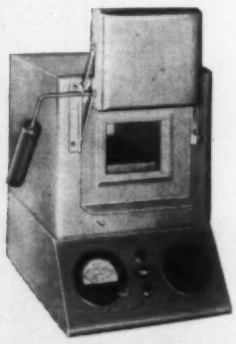
New two-way solenoid valve for hydraulic systems with operating pressures to 3000 psi. is designed for continuous duty, operating on 110-volt, 60-cycle a.c. Poppet type construction eliminates internal leakage and allows full line flow when opened. Valve may be mounted in any position. Impregnated coils, oil- and moisture-resistant, make new valve suitable for mounting in oil reservoirs. Available in ⅜-in. pipe size. —*Waterman Engineering Co., 721 Custer Ave., Evanston, Illinois.*



Mention No. 840 when filling out card.

Laboratory Furnaces

New "Series 1500" bench-type electric furnaces have stepless temperature controller (built into instrument panel) whereby current input can be regulated anywhere from 5 percent to 100 percent time "on" and any desired temperature from 350 F. to maximum can be selected and held. Furnace can be operated continuously at temperatures up to 1650 F. and intermittently to 1900 F. Instrument panel also houses an indicating pyrometer calibrated in both F. and C.



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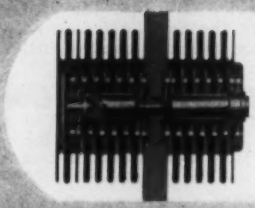

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scales, a toggle switch and neon signal light. "1500 Series" is available in two chamber sizes: 4 in. wide, 3½ in. high, 4½ in. deep, and 4 in. wide 3½ in. high and 9 in. deep. Separate models are supplied for operation on 115 and 230 volts. —*Thermo Electric Mfg. Co., 496 W. Locust Street, Dubuque, Iowa.*

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Inspection Kit for Lockbolts

New "AT-590-D" inspection kit (shown at top) aids shop man in checking installation of maker's aircraft-type

"Huck Lockbolts." Also announced are "AT-590-B" collar removing kit (center) and "AT-590-A" Master Kit with added countersink cutters. — *Aircraft Tools, Inc., 2306 E. 38th St., Los Angeles, Calif.*

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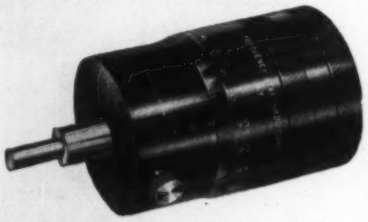
Micrometer Head

New type of precision micrometer head is specifically designed for electronic equipment. Size of thimble in all models is 2.12 in. diameter. Readability is enhanced by use of yellow colored scales against contrasting black anodized aluminum. Anti-backlash screw



thread, is compensated for thread wear, provides a positive spindle reading in either direction — important feature for many electronic uses. Temperature compensation is accomplished by use of Invar spindle and nut, spindle threads being hard chrome and the nut threads silver-plated to provide good wearing surfaces. Micrometer Head is available in English or Metric scales with 1-inch or half-inch thread travel in either scale. —*Frequency Standards Corp., P.O. Box 66, Eatontown, N.J.*

Mention No. 843 when filling out card.

A-c. Load Visualizer

New "Type AF-2" a-c. load visualizer combines five instruments in one: 0-2.5/5/25/50-amp. ammeter, 0-150/300/600-volt voltmeter, and can be used with a split-core or conventional instrument transformer to extend range for determining watts, vars, volt-amperes, and power factor. It can be applied in load

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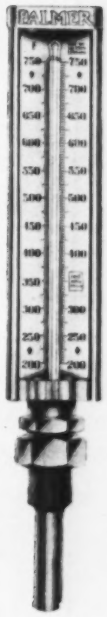

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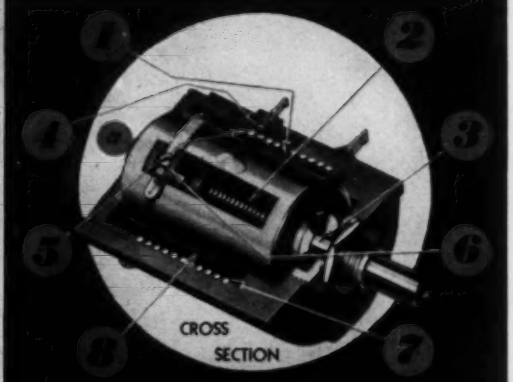

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lator, and a sturdy, felt-lined carrying case. In addition, instruments for higher ratings are available in similar kits which include "Type G-4" split-core current transformer with its leads. Accuracy of indication is within 2 percent for volts and amperes and within 5 percent for component amperes. Frequency range is 50-60 cycles.—*General Electric Co., Schenectady 5, N.Y.*

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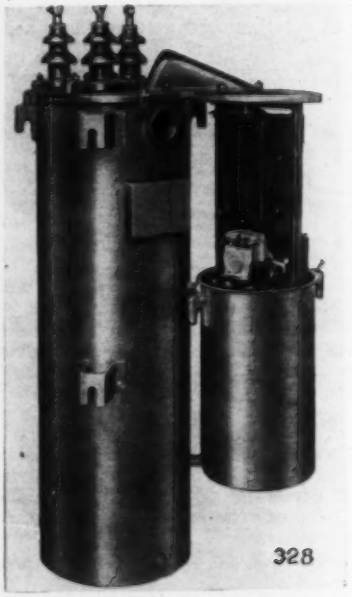
Feeder Voltage Regulator

New "JFR" pole-type voltage regulator is said to offer for the first time precise 0.62-percent step voltage control to small sizes of feeder distribution lines; is completely self-contained with automatic control and line drop compensation. Its quick-break mechanism utilizes same principle of balanced spring design as "AFR" and "DFR" station-type regulators. It is available now for 10.8-kva. 7,200-volt 15-amp. service and, according to makers, will provide as close voltage regulation as best station-type regulators.—*Allis-Chalmers Mfg. Co., Box 512, Milwaukee 1, Wis.*



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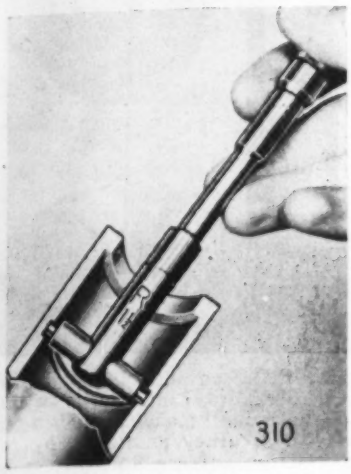

ing from dash No. 11 through dash No. 79. New semi-standard models, in addition to standard models, now read continuously from 0.490 to 12.020 in. —*Rimat Machine Tool Co.*, 1117 *Air Way, Glendale* 1, *Calif.*

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Radioactivity Counters

New "Type A" mica end window counter is made of stainless steel with fused glass mica-to-steel seal which remains tight indefinitely since there are no resins or gaskets to leak. Windows

are 2 to 3 mg. per sq. cm. and are 1.06 in. in diameter. Plateaus are several hundred volts long and have less than 5% slope per hundred volts. Life times are in excess of one billion counts. New counter is said to fill a long-felt need for a good end window counter.—*N. Wood Counter Laboratory*, 5646 *Harper Ave., Chicago* 37, *Illinois.*

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Air-gaging Spindle for Shallow Large-diameter Holes

New spider type gaging spindle prevents cocking and sticking in checking shallow large-diameter holes which offer a minimum of bearing; is used with maker's flow-type air gage; is much

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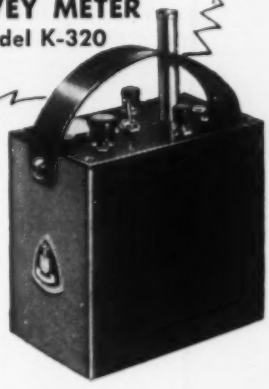
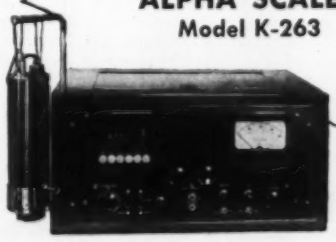


Unusually accurate measurements of gamma radiation in the two ranges of 100 mr/hr and 1000 mr/hr. Will read all intensities from cosmic ray background up to 1000 mr/hr equivalent gamma radiation.

ALPHA SCALER
Model K-263



The Keleket Alpha Scaler, Model K-263 is a parallel plate, air-ionization chamber scaler for counting alpha activity on thin, flat samples. Also features autocount, autotime and a scale selector for scales of 16, 32 and 64.

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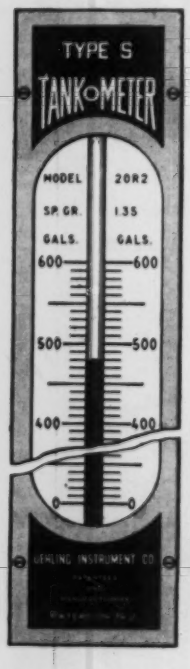

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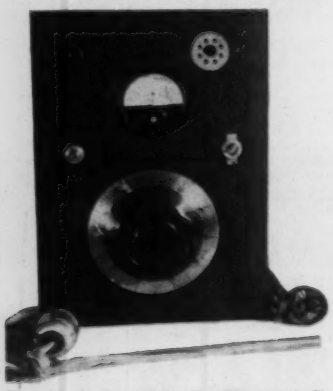

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8-in. x 10-in. Safety-relief Valve

New nozzle type safety-relief valve is world's largest, with 8-in. inlet and 10-in. outlet. It has been designed for refineries, etc. Orifice diameter is 5 in. Valve is designed for 300 psi. top pressure. Body is of cast steel with stainless steel trim. At 100 psi., valve relieves 116,000 lbs. of saturated steam. With water at 100 psi., it will pass 5,350 gpm.

at 25% overpressure. Among features: round wire springs calibrated for rating; guiding ratio is 2½ to 1 with close tolerances; piston guide is of small diameter to minimize effect of back pressure; complete baffle shields spring from lading fluid; stainless-alloy alignment spool provides perfect alignment and bearing from stem to disk; soft iron gaskets for back pressure conditions. —*Farris Engineering Corp., 552 Commercial Avenue, Palisades Park, N.J.*

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Universal Tester

New low-range model of hand-operated multi-range universal testing machine, said to be the first of its kind, has four scales: 0-10, 0-25, 0-50 and 0-100 lbs., calibrated in tenths of pounds, ounces or kilograms. Accuracy is 0.5

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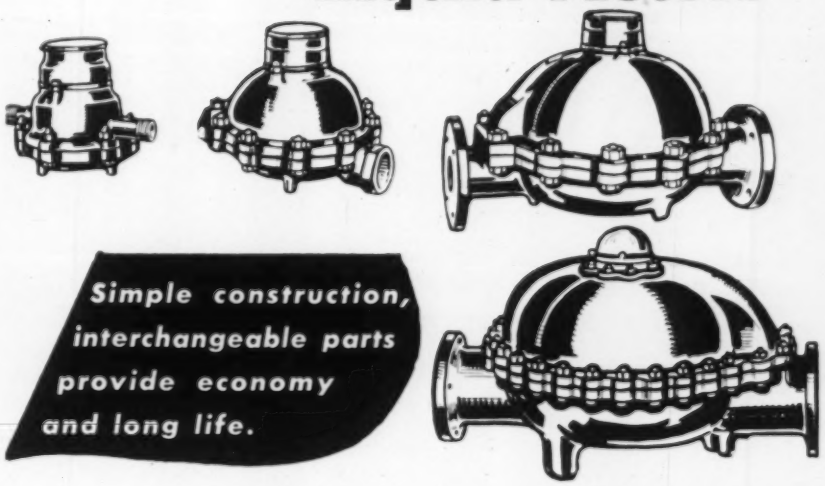

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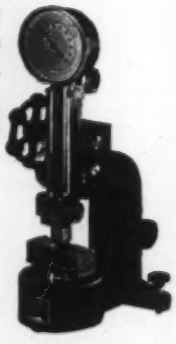

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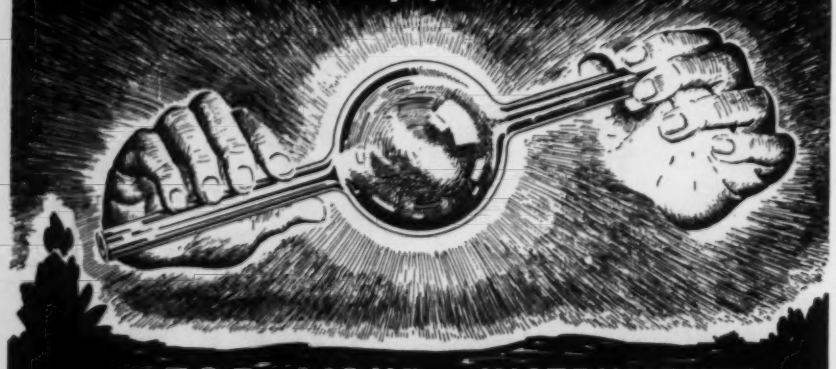

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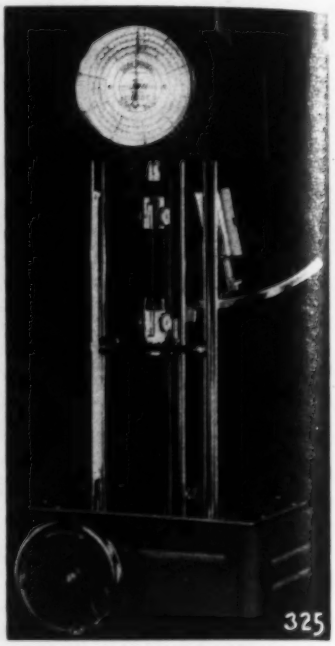

percent. A number of grips are available for rubber, wire, wood, etc. Standard model has 14.75-in. daylight opening between grips; extra-tall models 24, 36 and 48-in. openings.—*W. C. Dillon & Co., Inc.*, 5410 *W. Harrison St., Chicago* 44, *Ill.*

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Microhardness Tester

New "Model MO" Tukon Microhardness Tester for light load testing where there is not sufficient testing to warrant a fully automatic model, is made in both a floor and bench model. It applies loads

of 1 to 1000 grams and may be used with either Knoop or 136-degree Diamond Pyramid Indenters. Load is applied under dash pot control, speed of which may be varied from less than 0.040 in. per minute to as fast as testing permits without impact influencing the results. Both rate of application and duration of applied load may be controlled. Feature of this model is arrangement for removing load without operator having to touch instrument until indicator is out of impression.—*Wilson Mechanical Instrument Co., Inc.*, 230 *Park Avenue, New York* 17, *N.Y.*

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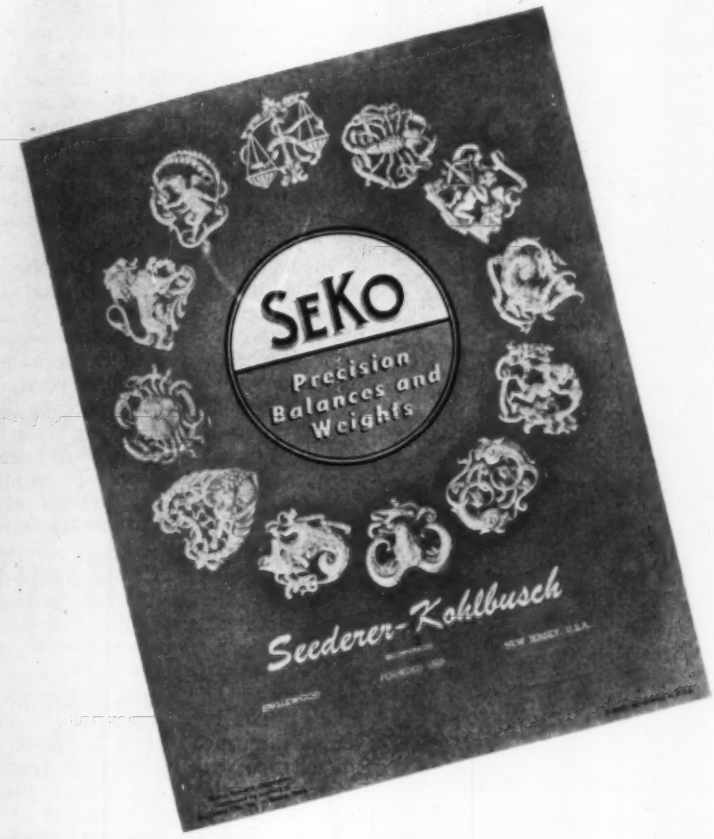

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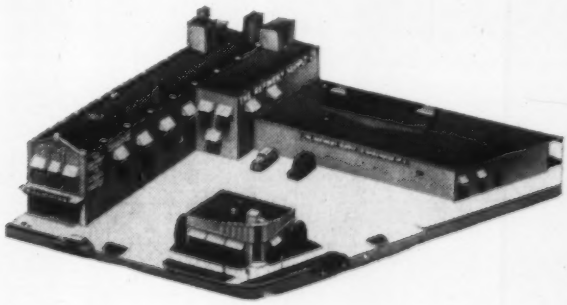

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New Method *of* Measuring Wear *of* Textiles

WASHINGTON, D. C. — A convenient nondestructive method for measurement of the abrasive wear of textiles has been developed by Dr. Herbert F. Schiefer, Lawrence E. Crean, and John F. Krasny of the National Bureau of Standards as part of a program sponsored by the Office of the Quartermaster General, Department of the Army. Depending only on the change in capacitance of the specimen with wear, the method is simple, rapid, and highly sensitive. As capacitance is measured without disturbing the specimen, readings may be taken at frequent intervals during a test and the rate of wear thus evaluated.

Although resistance to abrasion is an important factor in the serviceability of textiles, the laboratory study of this property has been hampered by lack of a satisfactory objective method. In addition to visual estimates of wear and measurements of the time required to abrade completely through a sample, a number of specialized procedures have been devised, based on changes in thickness, air permeability, light transmission, and breaking strength of the abraded material. However, none of these techniques has proved entirely adequate. Measurement of reduction in breaking strength has been widely used but has the obvious disadvantage that the specimen must be destroyed in order to determine its breaking strength. Thus it is not possible by this method to plot a consistent wear curve with data from a single specimen. Variations in thickness, while of some significance with heavy-pile materials, are not necessarily indicative of wear in ordinary fabrics. Changes in air permeability and light transmission are difficult to interpret in terms of wear since these properties may be altered by flattening of the nap with use.

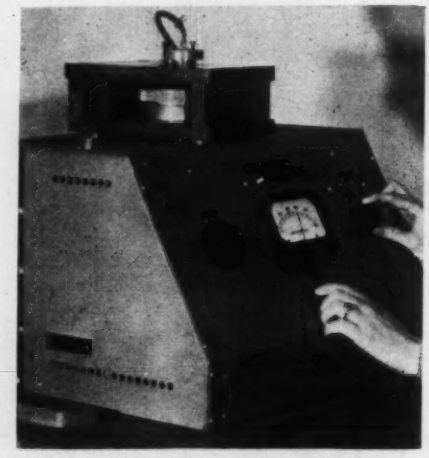


Fig. 1. Abrasive wear in textiles is quickly and conveniently determined at the NBS by means of the Bureau's new method which measures the change in capacitance of the specimen.

The method developed at the National Bureau of Standards, on the other hand, measures a property of the sample—namely, its capacitance—which is very closely related to the amount of material remaining in the portion of fabric tested. Since the specimen is not destroyed nor altered in any way during the capacitance measurement, a complete set of data may be obtained, showing the rate of abrasion at all times during the life of one specimen.

The new method requires only three capacitance measurements to determine the extent of wear in a specimen over any interval of time. The electrodes of a precision capacitor are first adjusted to be slightly farther apart than the thickness of the thickest specimen to be studied. The capacitance of the intervening air space is then measured. The capacitance with the unworn specimen between the electrodes is next obtained and, finally, the capacitance of the abraded specimen. The measure of destruction or ruin, Q, is then given in percentage by a simple formula.

In the laboratory testing of textiles, the capacitance of the abraded specimen is taken as the capacitance of a speci-

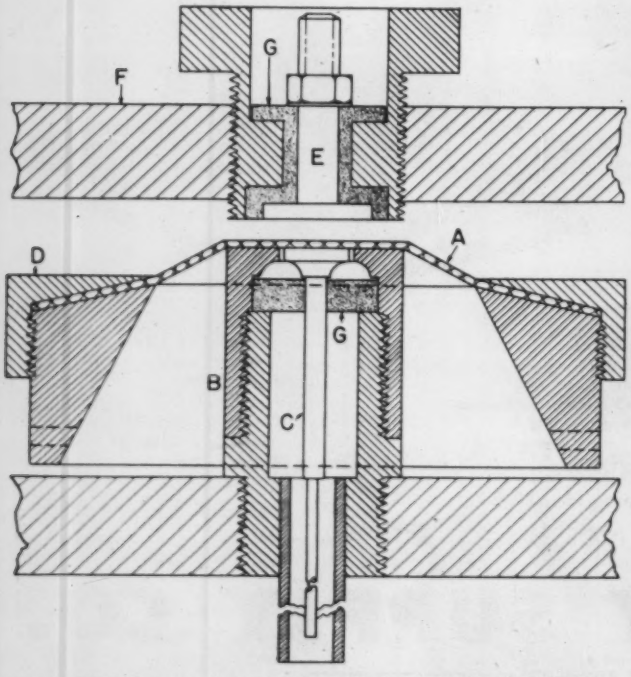
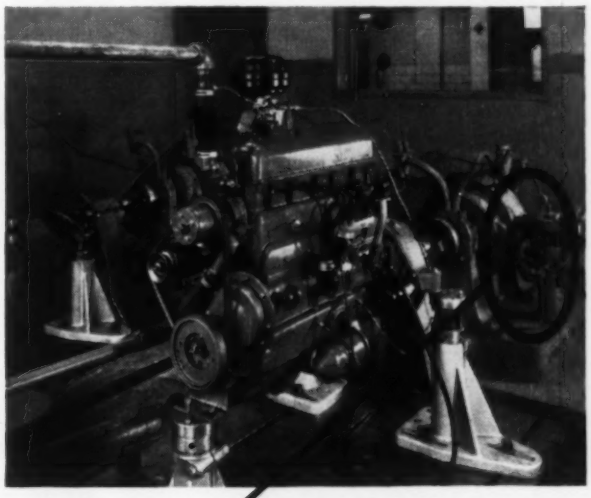


Fig 2. NBS capacitor for measuring abrasive wear of textiles. Specimen (A), resting on measuring electrode (C) and guard electrode (B), supports specimen clamp (D). Third electrode (E) is mounted in a heavy hinged lid (F), which can be swung down to a fixed stop after the specimen is inserted. This electrode forms part of a micrometer head. Insulating collars (G) serve to center the island and high-voltage electrodes.

Fig. 3. The improved Schiefer abrasion testing machine designed at the NBS. A plane abradant (above) and a plane area of a fabric (below) are placed in contact under a known pressure. The abradant and specimen rotate in the same direction and with the same angular velocity, but they must not be coaxial. Uniform abrasion is thus produced over the whole area of the specimen from every direction in its plane.

Endurance tests of engine parts employ Hagan THRUSTORQ



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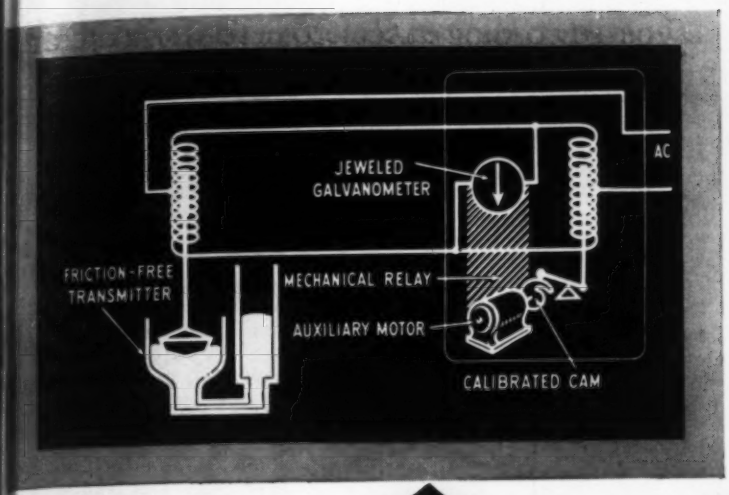
men after it has undergone R rotations against the abradant in an abrasion machine. If a number of values of Q are obtained for various values of R, then a wear curve may be plotted which is found to be characteristic of the fabric tested. In general, woven fabrics become unserviceable when Q approaches a value of 50 percent.

The Bureau's apparatus, Fig. 1, employs a capacitor of the guard-ring type, Fig. 2. In this device a high-voltage electrode is supported at a fixed distance from a smaller measuring electrode, which is surrounded by a guard ring to eliminate fringing. The larger electrode is connected to the high-voltage terminal of a bridge, and the measuring electrode and guard ring to the ground-potential terminals of the same instrument. Only that portion of the total flux from the high-voltage electrode which reaches the smaller electrode is measured by the bridge. The island and guard ring are so constructed that the specimen can be clamped with its worn area over these parts. The third electrode is mounted in a heavy hinged lid which can be swung down to a fixed position above the specimen. This electrode forms part of the micrometer head for adjusting the distance between it and the island electrode to precise known values. The capacitor is built for frequent use.

The capacitance method has many applications in addition to its use for simple abrasion testing. It may, for example, be employed as a quick and accurate means for exploring the uniformity of textile materials. Also, it has been found very convenient for measuring quantitatively the wear of different parts of a garment that has been subjected to a service test. Values of Q may be obtained over an entire area of the garment, and a map of the area made by plotting "iso-ruin" lines through points of equal Q.

Improved Abrasion Tester

The capacitance method of measuring wear was developed at the Bureau for use with the improved Schiefer abrasion testing machine, Fig. 3, which has been adapted for testing a large variety of materials under a wide range of conditions. The original model of the machine was designed by Dr. Schiefer in accordance with a mathematical solution to the problem of abrading a specimen uniformly in all directions. This solution requires that plane areas of abradant and specimen, in contact under constant pressure, rotate in the same direction with the same angular velocity but on different axes. The later model has been designed for greater rigidity, and new types of abradants and specimen holders have been developed. Abrasive wear produced on a variety of materials with this model has been measured by the capacitance method and found to be extremely uniform over the abraded area. Results on woven fabrics have been shown to be very similar to those obtained in actual service.



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Panel-type Recording Accelerometer *for* Aircraft

WASHINGTON, D. C.—A novel type of accelerometer which gives both an instantaneous indication and a record of the acceleration of an airplane in flight has been developed by A. S. Iberall of the National Bureau of Standards for the U. S. Air Force. Outstanding features of the device are compactness, which permits mounting on an instrument panel, and the use of spark recording to obtain a readily-available record on a paper chart. The details of the design are such that small panel-type recorders of other physical conditions—temperature, pressure, or voltage, for example—can be similarly constructed to occupy a space not much larger than an ordinary indicating instrument.

Immediate application of the new accelerometer is in the training of aviators for combat flying, where sharp turns must be made at high speeds. Practice in making such turns can be more effectively obtained if the instrument planel of the plane is provided with an accelerometer that gives an instantaneous visual indication of acceleration while the maneuver is being executed. At the same time, it is desirable to have a record of acceleration for quick reference after a flight has been completed. However, the accelerometers that have been available are either too large for instrument-panel mounting or, if small enough for panel use, do not provide an automatic record of acceleration. Moreover, as most recording accelerometers require photographic equipment, interpretation of the trace must usually wait until the film has been developed. The Air Force therefore requested the NBS to undertake the development of a small, compact indicating and recording accelerometer that would meet flight train requirements.

A sliding bob mounted on a sh and restrained by a helica spr serves as the acceleration-sen ive e ment of the device. Acceleratio of s aircraft along the axis of the aft d places the bob by an amount propo tional to the acceleration, at the sa time compressing the spring. The va ing displacement of the bob from t rest position is permanently record on a paper chart by a repetitive hig voltage spark occurring at the positio of the bob. An instantaneous indica tion of acceleration is also obtaine since the record paper is visib through the transparent front of th accelerometer case immediately afte puncture.

The accelerometer constructed a the Bureau is built into a rate-of-climb indicator case of the standard aircraft panel type. By means of the zero-set ting shaft of the rate-of-climb indi cator, power from a small synchronou timing motor for driving the recor chart is transmitted from the back t the front of the case without obstruct ing the available space. Sprocketed rollers mounted just behind the front of the case are thus made to pull the recording paper across the inner face of the cover and push it out the side of the case, where it may be torn off. As the recording paper passes across the face of the instrument, it is punctured by sparks at a 60-cycle repetition rate. The writing electrodes consist of a nickel tip projecting perpendicularly from the bob, and the edge of a narrow strip mounted on the inside of the cover directly under the tip. The bob and nickel tip are made the high-voltage electrode while the plate and

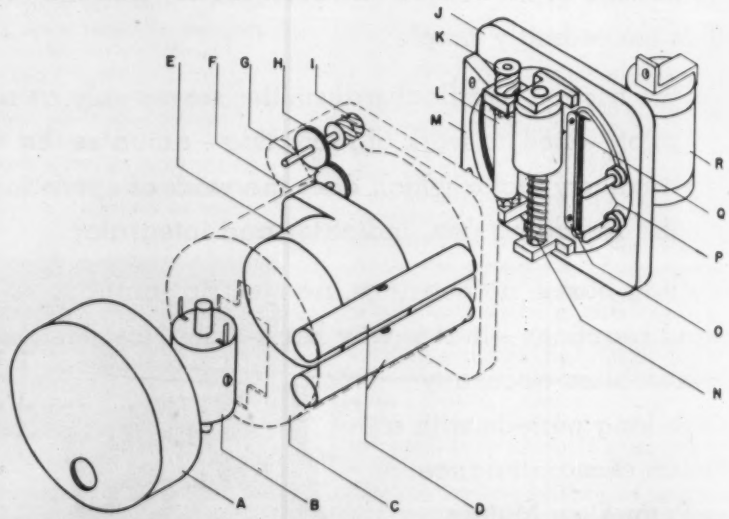

Fig. 1. Schematic diagram of new indicating and recording accelerometer. Accelerometer unit makes use of the inertia of a sliding bob mounted on a shaft and restrained by a helical spring. Spark coil produces a high-voltage spark between the plate electrode (O) and a nickel tip on the side of the bob. This spark pierces a moving chart. The accelerometer is built into a rate-of-climb indicator case (C). Power for driving roller shaft, which unwinds the record chart, is transmitted from synchronous motor to the front of the ca by means of shaft, spur, gear, and spiral gea which engages spiral gear K. Sprocketed roll on shaft L are thus made to pull the recordi paper from a 35-mm film cartridge (R) acro inner face of cover and push it out the side of t case, where it may be torn off. Current is brou to the bob through insulated banana plugs so th removal of the cover for loading the record w cut off the voltage to the electrodes.

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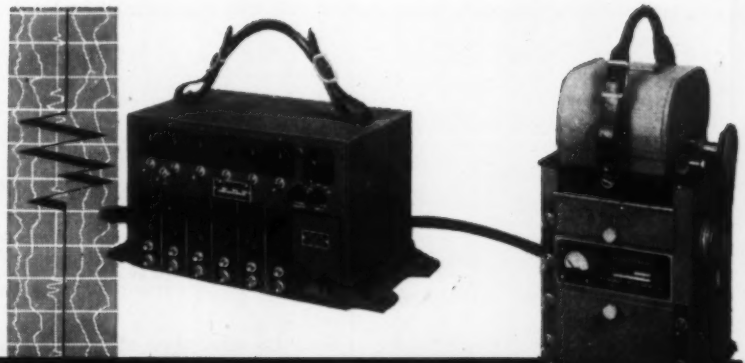

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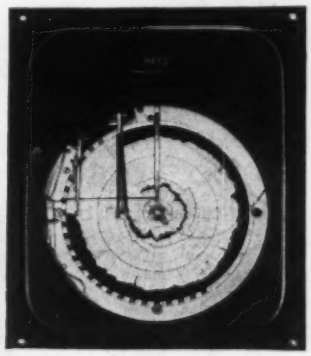

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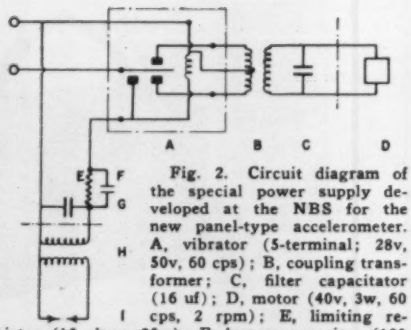

Fig. 2. Circuit diagram of the special power supply developed at the NBS for the new panel-type accelerometer. A, vibrator (5-terminal; 28v, 50v, 60 cps); B, coupling transformer; C, filter capacitator (16 uf); D, motor (40v, 3w, 60 cps, 2 rpm); E, limiting resistor (15 ohms, 25w); F, bypass capacitor (100 uf); G, tuning capacitor (4 uf); H, spark coil; I, spark gap.

other parts are grounded to permit removal of the cover without risk of electric shock. The high voltage is provided by a small model-airplane spark coil mounted behind the motor.

The linear speed of the record chart is about 6 inches per minute. The cartridge for storage of the record chart is mounted in a semi-cylindrical depression in the outside of the transparent plastic cover, which is slotted to receive the tangent lip of the cartridge.

The necessity of operating the accelerometer aboard a plane from a 28-volt d-c. source required the development of a special power supply. A 60-cycle vibrator is employed in the usual way to produce 60-cycle alternating current for the motor. However, the power dissipation of the small paper coil makes operation by a repetitive voltage "pip" most desirable. This pip is supplied by the inductive decay of the vibrator coil on the "break" of its main reed contact.

In laboratory performance tests at the National Bureau of Standards, the accelerometer successfully withstood shock and vibration of at least 15 *g*. Paper speed was found uniform to within a few percent. The record obtained was easily interpreted and adequate for resolving detail of amplitude not less than 2 percent of the total record width.

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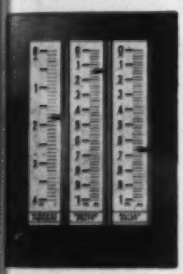

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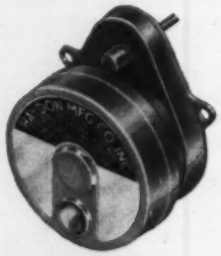

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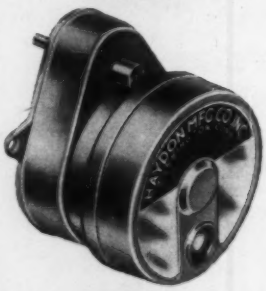

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Purpose of the laboratory will be t set standards in non-destructive testin methods that will (1) make them mor effective in raising the quality of ord nance and other military equipmen used by the Navy, and (2) decreas the cost of non-destructive testing fo the benefit of Navy suppliers. It wil also do research into new technique of x-ray and other non-dectructive test ing methods (magnetic, sonic and flu orescent-particle inspection).

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Next meeting, September 15th.

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The September meeting of the Society fo Applied Spectroscopy will be held on Septembe 13 at 8 p.m. at the Socony-Vacuum Trainin Center, 63 Park Row, New York, N. Y. Subject Business Meeting. Short Paper: "Photographi Emulsions," by Mr. R. Pomatti, Research Labo atories of Texas Oil Co.

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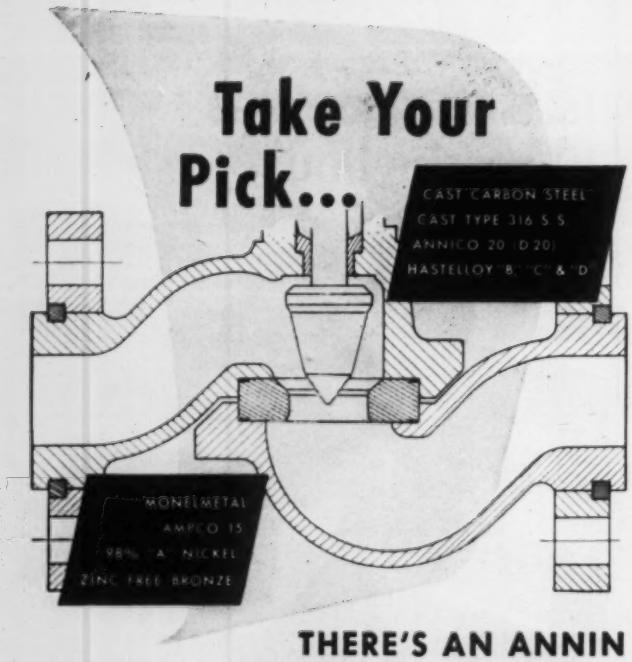

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trodes were short-connected to the discharge he... er a... proximately 2 ft. downstream. Valve stroking tim... of ... regulator was reduced as much as possible (8.0 ... cond... and reset rate quadrupled over its standard ratin...

The important feature of the redesign is effe... ive s... duction of necessary tank capacity by eliminati... it e... tirely from the control loop and applying a high-s... ed p... portional regulator to a low-residence system (e... entia... pipe-line control). In other words, two importan... thing... have been accomplished: (1) the tank capacity has ...een s... duced, thus lowering costs; and (2) the over-all res... ts ha... been materially improved.

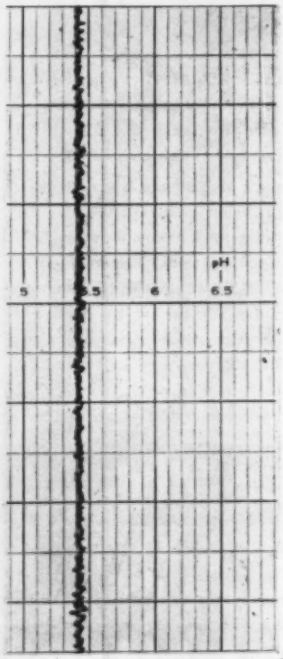

Fig. 32. Record of effluent pH from residence in process of Fig. 31-B. Process controlled by regulator on influent stream.

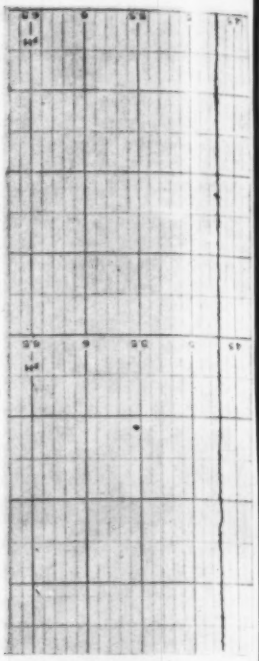

Fig. 33. Record of effluent pH from residence in process of Fig. 31-B. Corresponds to control cha... of Fig. 33, but illustrates relative stabilizing effect of operating a... lower control point in region o... lower buffer index.

On the average, the record of regulated pH entering the residence system, resembled Fig. 25-A with a total band width of 0.6 to 0.8 pH, while corresponding effluent pH of the residence is given in Fig. 32. The effect of buffer index on over-all results is apparent from Fig. 33 which represents control at lower pH and correspondingly lower buffer index.

These results are not to be misconstrued to mean that there is an optimum valve-stroking time for proportional-position pH regulators. This time factor should be as low as possible (theoretically zero) and the valve should move to its new position instantaneously. The above analysis was given only as an experimental approach to limitations of application of proportional pH regulators.

Moreover, the concept of instantaneous valve movement applies only to the proportional-position pH regulator since its function is to establish a fixed valve *position*, proportional to pH deviation. Proportional-speed floating regulators, on the other hand, have no fixed relationship between valve position and pH deviation. Their function is to move the valve at a *speed* proportional to pH deviation and the valve movement continues to limits, if necessary, until load change is corrected.

* * *

Another example of the relative effect of reaction period of residence system and regulator, is given in Fig. 34. Different "runs" of this process required widely different control-point settings, which also varied reaction period of the process by virtue of a corresponding shift in buffer index. Each new setting of the control index would have re...

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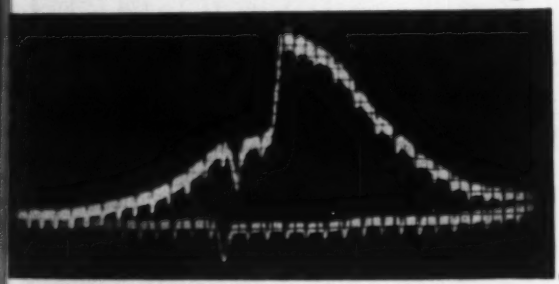

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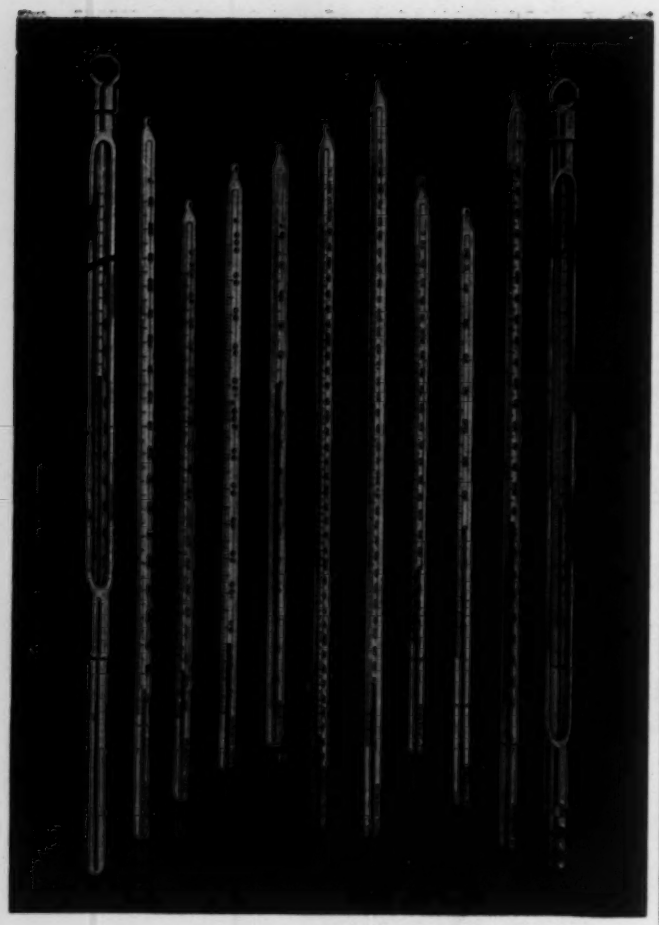

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quired a comparable readjustment of reaction period of either the process or the regulator. If the process retention remained fixed, readjustments of proportional band were necessary with changes in control point, or, if proportional band could be fixed, a corresponding change in retention of the process would accomplish the same thing.

Proportional band was fixed at the value required to handle the worst condition of high buffer index at maximum retention and the reaction period of the process was varied by changing retention with changes in control index. This advantage was taken of the residence period of the process which was varied automatically by means of a level controller having its control index coupled pneumatically to the

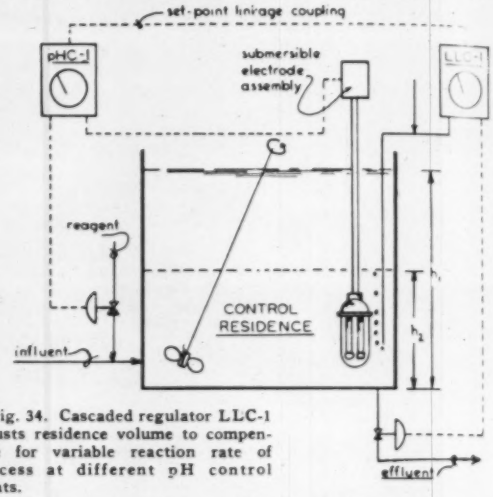


Fig. 34. Cascaded regulator LLC-1 adjusts residence volume to compensate for variable reaction rate of process at different pH control points.

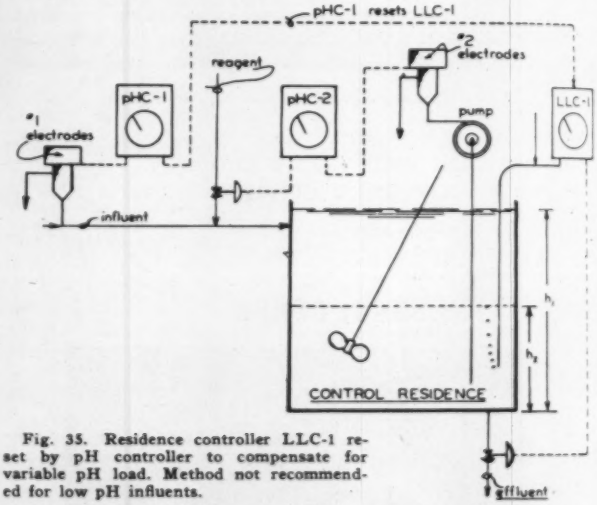


Fig. 35. Residence controller LLC-1 reset by pH controller to compensate for variable pH load. Method not recommended for low pH influents.

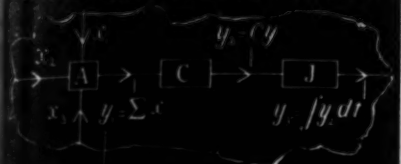
pH control index so that one followed the other in accordance with a fixed program. Proportional band setting of the pH regulator remained fixed and the relay cabinet locked, thus obviating the necessity for questionable adjustments by the operator and possible meddling by unauthorized personnel.

Although this control has unique features, it is not recommended for processes having high buffer index or widely fluctuating acidity loads and/or changing throughput. It has been used in the relatively low ranges of buffer index and under moderate loading with constant throughput, but application under more severe conditions would probably offer no material advantages.

The same principle of cascading has been applied to compensate for variations in influent pH load which required frequent settings of proportional band adjustments; and favorable results have been reported. A simple proportional pH controller, connected to the influent line (Fig. 35) is cascaded with the control index of residence controller LLC-1 and varies retention as a function of influent pH.

Although favorable results are reported, the system operates under light load changes and is not recommended

from BLOCK DIAGRAM



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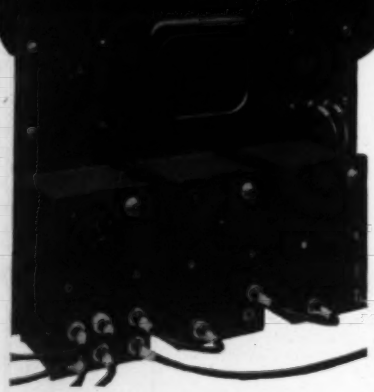

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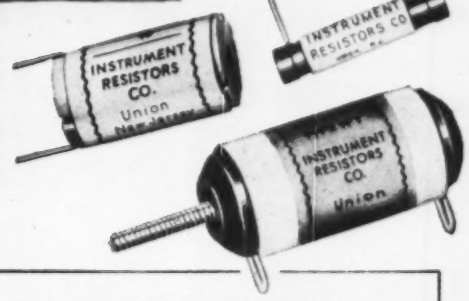

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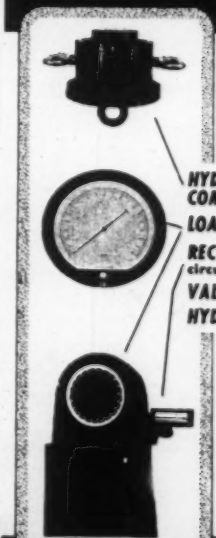

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for strongly alkaline or acid solutions which must be neutralized to the steep portion of the acidity characteristic. Whenever it is necessary to regulate to near neutrality a strongly acid or alkaline solution which varies widely in pH load, there may be decided advantages in the use of cascaded residences rather than cascaded regulators of the foregoing types. The reason for this is suggested by an inspection of the acidity characteristic, see Fig. 4. Small changes in pH in the extreme low or high ranges are amplified non-linearly many-fold in the neutrality range, and rate response is increased considerably beyond the practical turndown range of a single regulator, thus necessitating supplemental stabilization.

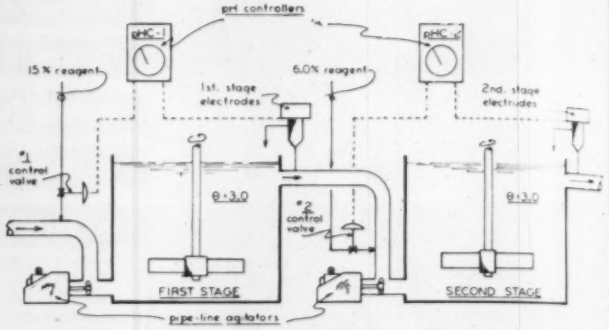


Fig. 36. Two stage pH control process incorporating cascaded single-capacity residences with unit pH regulators. System recommended for applications having large and variable pH loads.

The general effect of residence is twofold: It reduces the magnitude of pH change and it reduces the rate of change. A series of such residences, either interacting or non-interacting, as illustrated in Fig. 30, is an effective way of controlling strongly acid liquors which vary widely and abruptly in pH load.

The mechanism of multi-stage regulation, or, what might be more properly designated a multiple-residence system, is essentially an expansion of the forgoing laws of residence to define the behavior of two or more tanks connected in series. Although a multi-stage system is made up of multiple cascaded capacities, it is not to be viewed in the same light as a multi-capacity process (e.g. two-capacity) as controlled by a single regulator. The essential difference is the application of a unit regulator to each unit residence, which, so far as the regulator is concerned, is a single-capacity process.

It has already been pointed out, with reference to Fig. 29, that a retention tank is essentially an exponential generator: it converts linear changes in concentration of the influent into exponential changes in concentration of the effluent. When the effluent of one stage becomes the influent of a second or of n stages, the over-all effect is to expand the resultant concentration change by an exponential series. For example, if y is the fraction of liquor retained by the system longer than time t, the effect of a single capacity is

$$y=C/C_0=e^{-t/\theta} \quad \ldots\ldots\ldots\ldots\ldots\ldots (13)$$

For a two-stage cascaded system, the relationship between influent concentration of the first tank and effluent concentration of the second tank, is

$$y_2=e^{-t/\theta}[1+(t/\theta)] \quad \ldots\ldots\ldots\ldots\ldots\ldots (14)$$

A three-capacity cascaded system expands the series thus:

$$y_3=e^{-t/\theta}\{1+[t/\theta]+[(t/\theta)^2/2]\} \quad \ldots\ldots\ldots\ldots (15)$$

Likewise, for a four-capacity cascaded system:

$$y_4=e^{-t/\theta}\left[1+\frac{t}{\theta}+\frac{(t/\theta)^2}{2}+\frac{(t/\theta)^3}{6}\right] \quad \ldots\ldots\ldots\ldots (16)$$

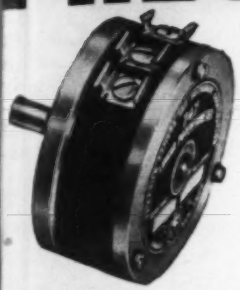
and for five capacities:

$$y_5=e^{-t/\theta}\left[1+\frac{t}{\theta}+\frac{(t/\theta)^2}{2}+\frac{(t/\theta)^3}{6}+\frac{(t/\theta)^4}{24}\right] \quad \ldots\ldots (17)$$

where symbols have the designations given elsewhere in the text.

A graphical illustration of this effect is given in Fig. 37 which is a plot of the above equations corresponding to the respective numbers of cascaded units, and expresses the

PRECISION



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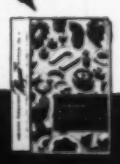

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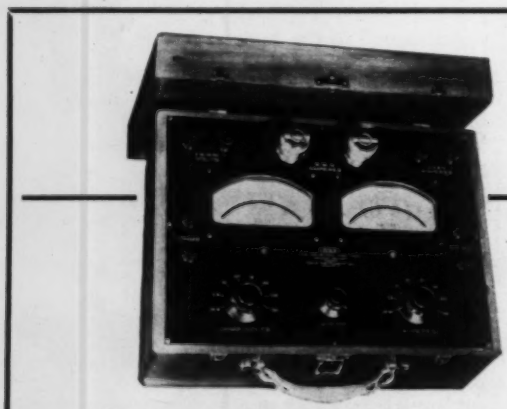
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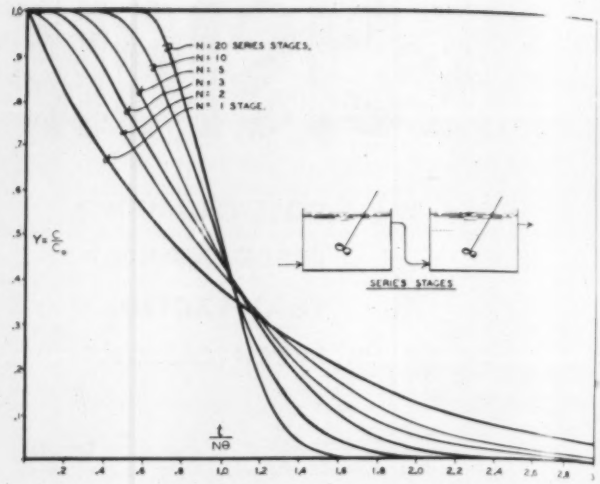

Fig. 37. Effective change of concentration in system of cascaded residences.

holding time of a multiple unit process. By plotting these data as a rate function, or

$$\frac{dy}{d[t/(n\theta)]} \text{ vs. } \frac{t}{n\theta} \quad \ldots\ldots\ldots\ldots\ldots\ldots (18)$$

we obtain Fig. 38 which expresses the distribution of concentration throughout the process for various numbers of units in series. This plot reveals the tendency of the system to approach a limiting value corresponding to the nominal holding time whereby effective short-circuiting is decreased and the system approaches a batch process in reaction efficiency. There is a definite relationship between unit stage volume V and throughput rate F required to obtain a desired end result in cascaded residences. The system cannot be built up indiscriminately without regard to unit retention θ if the desired end results are to be achieved in keeping with cost efficiency and gain per dollar. There is a practical efficiency limit to the number of stages selected since, as n increasese with or without corresponding changes in θ, the exponent $t/n\theta$ becomes less than unity which reduces the effect of the nth tank to

$$y_n = 1 - (t/n\theta) \quad \ldots\ldots\ldots\ldots\ldots\ldots (19)$$

which means that if the number of cascaded stages is made large, the nth tank behaves simply as a displacement basin and no residence action takes place. In other words, the preceeding stages have leveled the load changes to uniform concentration.

The order of reaction likewise has bearing on the relationship between influent concentration of the input tank and the effluent concentration of the output tank. For example, the effluent concentration C_1 of the first tank in equation

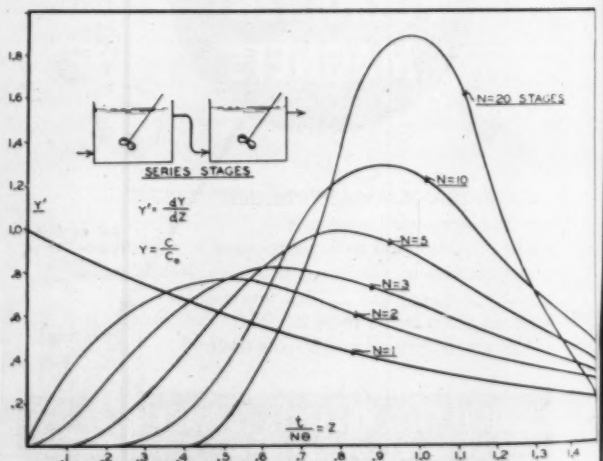

Fig. 38. Distribution of concentration gradient in cascaded-residence systems containing n number of tanks in series.

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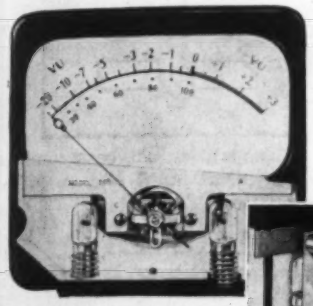

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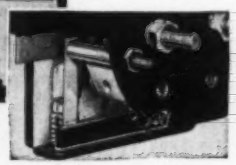

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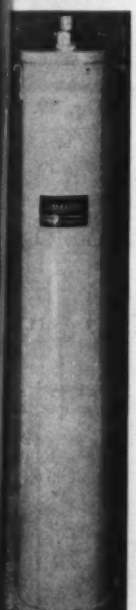

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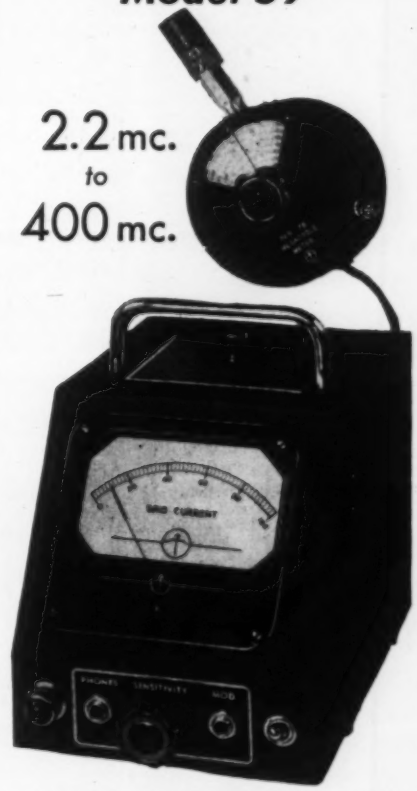

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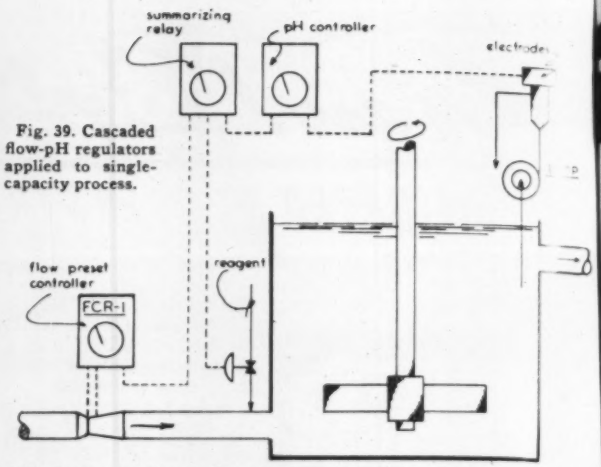

Fig. 39. Cascaded flow-pH regulators applied to single-capacity process.

(6), becomes the influent concentration of the second tank, and the relationship between initial input and output concentrations is given by the equation

$$C_2 = \frac{C_1}{1 + k\theta_2} = \frac{C_0}{(1 + k\theta_1)(1 + k\theta_2)} \quad \ldots\ldots\ldots (20)$$

Similar conditions hold for second-order and third-order reactions.

As an illustration of the practical application of the above principles, the following examples of typical control installations will be given:

A waste acid neutralization process had been designed with a retention of $\theta = 3$ times nominal throughput rate. It was equipped with a conventional proportional-position pH regulator. Acidity load varied several hundred percent; and throughput rate varied abruptly from +200% nominal to −200% nominal. It was not possible to regulate pH within closer limits than ± 4.0 pH with the original equipment and it became necessary to redesign the process to incorporate the cascaded control system shown in Fig. 39. A flow-ratio controller varied reagent feed directly as a function of waste acid flow; and its ratio was reset by a pH controller operating on the effluent stream from the main retention tank.

This system reduced the final control band to ± 2.0pH, but analysis of daily consumption of reagent indicated that further expenditures of money were justified if the control band could be reduced to ± 1.0 pH. This was accomplished by redesigning the process to incorporate a low-retention high-reaction-rate flash-mix chamber ahead of the main retention tank. A low-time-constant pH controller, having extremely fast reset rate and low proportional-band adjustment (20%) was installed on the flash mix tank and cascaded with the flow-ratio controller as illustrated in Fig. 40. A

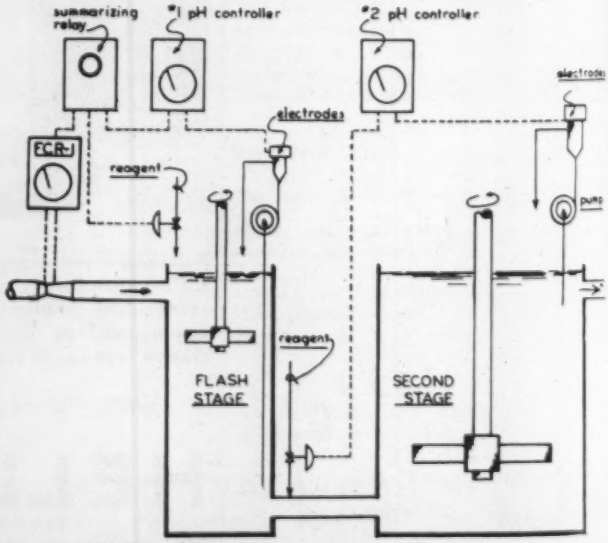

Fig. 40. Two-stage pH control process, incorporating cascaded flow-pH regulation in first stage and unit pH control in second stage.

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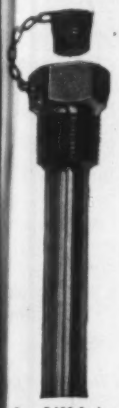

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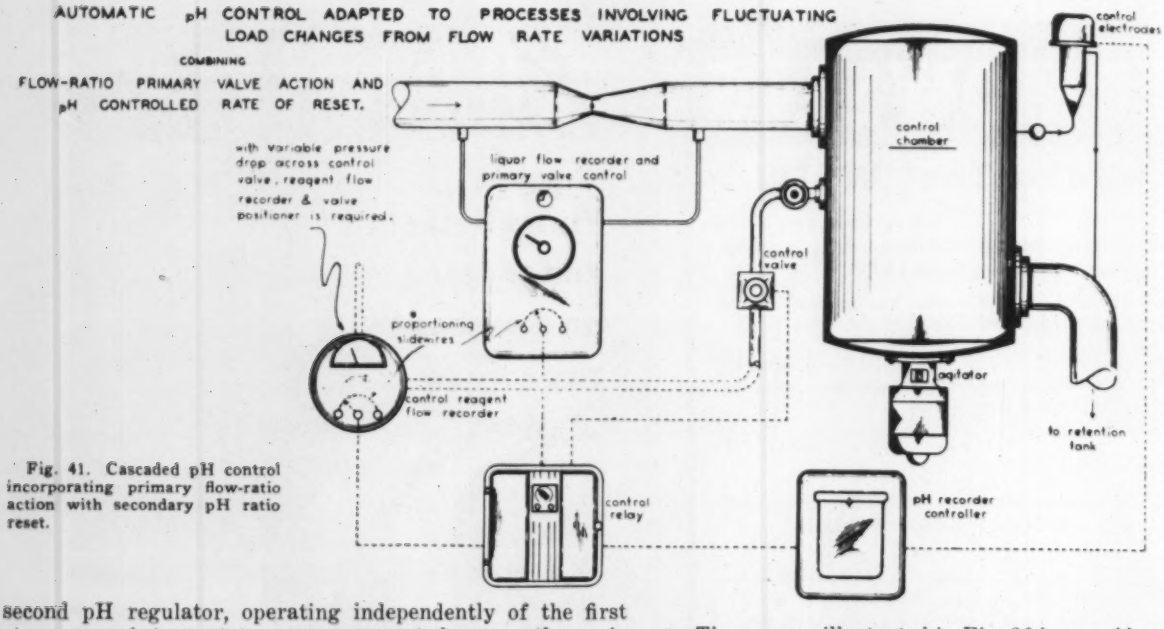
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to retention tank
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Fig. 41. Cascaded pH control incorporating primary flow-ratio action with secondary pH ratio reset.

second pH regulator, operating independently of the first stage cascaded regulators, was connected across the main retention tank which was cascaded interacting with the flash-mix chamber. Although the intermediate pH regulator produced a cycling record of ± 3.0 pH band width, and with an average period of 60 seconds, the final controller maintained effluent pH constant within ± 0.5 pH at 7.0 pH for more than 90% of the day's run.

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The process illustrated in Fig. 36 is an acid neutralizatio system wherein raw influent varied abruptly between limit of 1.0 pH to 4.0 pH or any intermediate value. A two stag residence was used with unit retentions of θ=3.0, and proportional-position pH regulator was applied to each uni The reagent feed line and control valve for each respectiv stage was connected to the influent pipe-line about two fe upstream from a pipe-line agitator which was close-connec ed to the control tank. Each tank was equipped with a turb agitator and the electrode sample was taken from the dis charge line of each respective unit. Control point of th second and final stage was 7.0 pH, while control point of th

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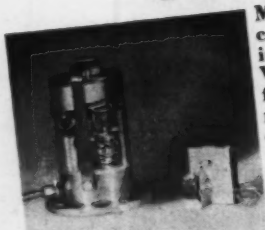

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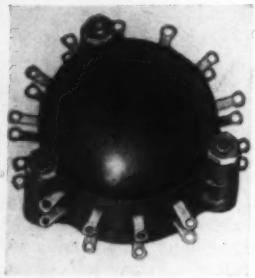

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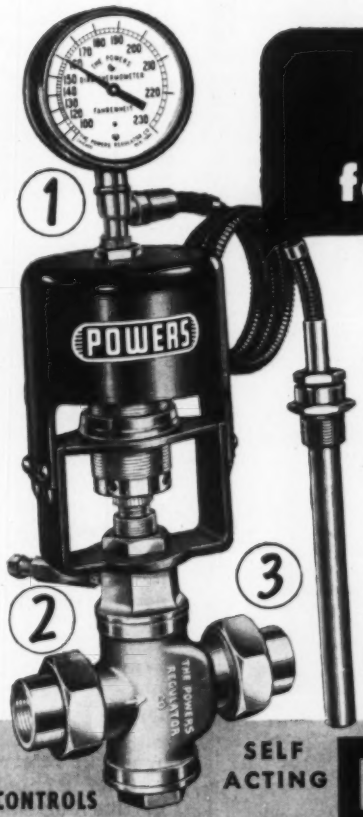

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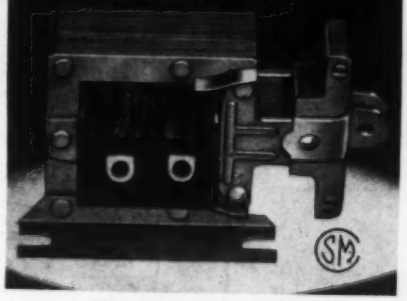

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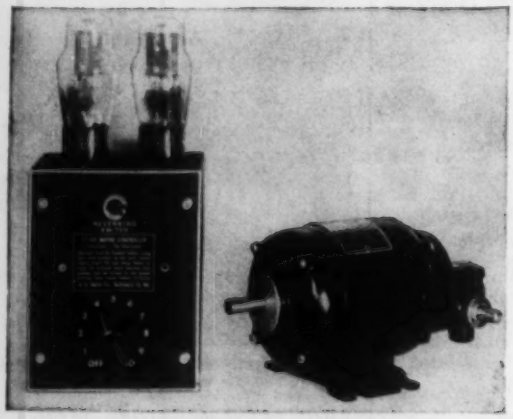

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first stage was experimentally adjusted to give the best over-all performance of the system.

The process was adjusted by setting the final stage control point to the prescribed value and adjusting the other variables to give best results and it was found that by operating the first stage at approximately 4.0 pH and a throttling range of 300%, the over-all performance was held to within 1.5 pH to 2.0 pH, with throttling range of the second stage set at 800%. Reagent strength of the two stages was experimentally varied and found to produce the best results when a 15% reagent was used for the first stage and 6.0% in the second.

One would expect, theoretically at least, that derivative regulators applied to a multi-stage pH process would permit greater reduction in residence volume than is possible with proportional-position regulators. Their effect is to restrict the residence reactions to a smaller range of the residence characteristic curve. This *controls* the residence and does not permit its rate reactions to vary so widely as does the proportional-position regulator. However, the writer's experience with derivative regulators has been confined to single-capacity processes, and experience with multi-stage control has been limited to proportional regulators. Nevertheless, multiple staging is a series of single capacities and it might be expected that benefits could be derived from derivative regulators operating in such a system.

* * *

The control engineer must often weigh the relative advantages of using a conveniently large control tank against the cost advantages of a cascaded control system which will do the same job. As an example of how cascaded controllers may be applied to effect a reduction of residence volume, the reader is referred to Fig. 41 which describes a regeneration unit using sulphuric acid as the control reagent. The volume of this unit was fixed and was too small to provide good regulation with a simple proportional-position regulator. To increase volume of the regenerator and install an acid dilution system would have entailed a large expenditure of money. Instead however, a ratio-flow controller was cascaded with the pH controller as shown with satisfactory results. Control band was held within 0.3 pH, and the original process design was retained with only the cost of additional flowmeters and a special relay.

In water treatment or sewage disposal plants, it is often customary practice to run the treated material into large quiescent basins to permit flocculation of suspended matter. Floccing chemical is added to a specified pH, but, because of

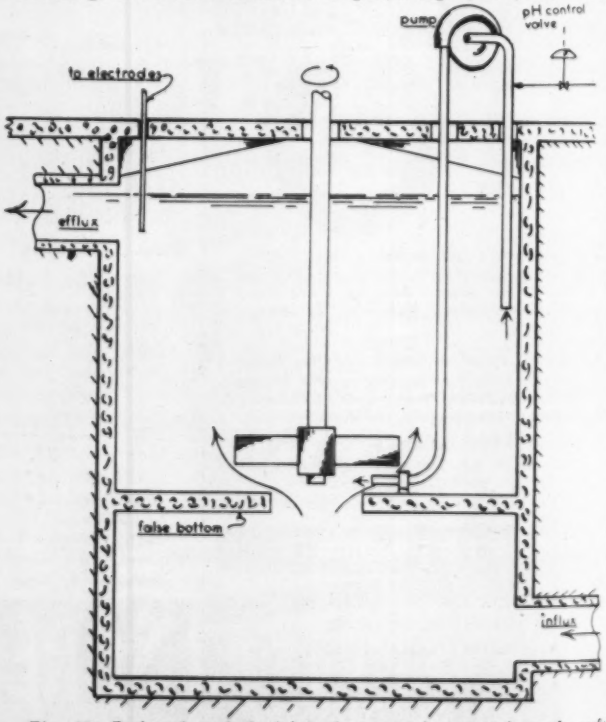

Fig. 42. Preferred method of injecting control reagent beneath surface of tank contents to inaccessible or submerged inlet openings.

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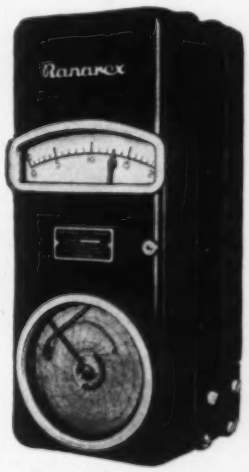

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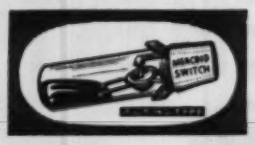

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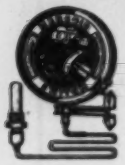

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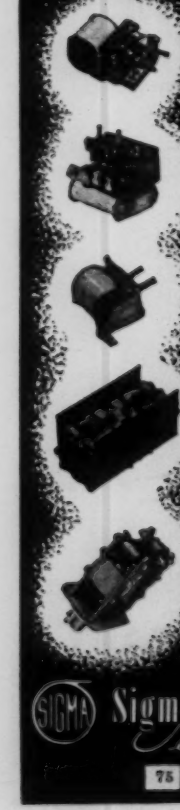

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equilibrium lag in the system, the clarified water changes pH slowly but progressively throughout the basin. This transfer lag from discharge to inlet of the basin is prohibitive for ordinary control and it has become necessary to cascade a pH controller at the discharge with another pH controller at the inlet or with a flow-ratio regulator which proportions reagent flow as a function of water inlet flow at a ratio established by the effluent pH controller.

Again, in water-treating practice, the control engineer may frequently encounter large sumps or clear wells which are cast of concrete as part of the building's foundation. Some of these sumps, like the one illustrated in Fig. 4.2, have false bottoms with inaccessible bottom inlet and top outlet thus making the problem of reagent addition rather difficult. Addition of reagent at the accessible surface introduces large short-circuiting errors which result in unstabilized control. Problems of this kind have been overcome in the writer's experience by withdrawing a constant volume of water from the sump through a centrifugal pump and discharging it through a suitable pipe-line near the bottom inlet of the sump. The control valve feeds reagent to the suction side of the pump as illustrated.

* * *

In general, residence has many useful functions in the chemical process and accomplishes certain tasks which cannot easily be accomplished otherwise. It has been claimed by some control engineers that the addition of a large tank to a pH control system is the most effective thing which one can do to stabilize the control. While this may be true under certain circumstances, it is not said with equal regard for the relative effects of other variables. If one thing can be regarded as more effective than anything else in stabilizing pH control, it would certainly be the buffer index of the process. pH is a non-linear function; and a low buffer index will go a long way to cover up the ills of a poorly engineered control installation. The relative effectiveness of buffer index and retention might be illustrated by the example that in one typical neutralization process a shift of the controller set point by 0.2 pH resulted in a change of 2.0 in buffer index, which gave the same stability of control as a reduction in level of tank contents to one-fifth the required level at the original set point. In other words, a change of 2.0 in buffer index had the same control stabilizing effect as a change of 5.0 in residence volume.

It is to the engineer's advantage to consider all variables of a pH control process in terms of their relative effects. In some cases he may encounter processes which have been designed without regard for the requirements of one or more of the variables, and the process may be so constructed that changes cannot be made to meet the requirements of any one variable. It may be possible, in some cases, to adjust other conditions to compensate for deficiencies in one requirement. For example, a waste disposal process had been designed without adequate residence volume and the tank was made of reinforced concrete buried beneath the ground. It was not possible to change the tank dimensions nor was it possible to apply multi-stage control or effective cascaded regulators without costly redesign. At maximum throughput, retention $\theta = 1.5$, the controller cycled with a total band width of $\pm$ 2.0 pH under worst conditions. The controller had been rebuilt on the job to increase its reaction rate to the maximum possible limit; and all lags had been pushed to the absolute minimum commensurable with limitations of the process. Nothing else could be done, and a total band width of 4.0 pH represented the best control obtainable under the circumstances.

However, advantage was taken of the effect of buffer index to compensate for deficiencies in residence volume. A second plant effluent contained a large concentration of waste organic matter, which, generally, has the effect of buffering pH changes. This stream was partly diverted into the waste mineral acid stream, with the effect of lowering its effective buffer index. Although the added flow rate under worst conditions reduced retention to approximately $\theta = 1$, the effluent pH cycled, under worst conditions, approximately $\pm$ 1.3 pH, or a total band width of 2.6 pH, which was an acceptable improvement over original conditions.

To be continued

JOURNAL of the Instrument Society of America

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Vol. 4 — **AUGUST 1949** — **No. 8**

General News

NEW SECTION OFFICERS

Three more sections have announced their lists of officers for 1949-1950 since the last issue of the Journal:

Cincinnati
Pres., Donald H. Abbott
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Section News

ARUBA

The thirty-third meeting was held on July 5, 1949. Three new members were added to our roster as a result of voting in this meeting. Section By-laws were revised, as the results of two motions, to allow us to conduct business and voting on membership applications more easily. Five minutes of the business meeting was devoted to a report on the activities of the National Membership & Sections Committee. This report was well received and it is planned to devote five minutes of every business meeting to similar reports. We are hoping that more information from the national committee will be made available for these reports. D. E. Merritt, our member located in Maracaibo, Venezuela, made a special trip to this meeting of our section to hear himself voted as our National Delegate to the St. Louis Convention. This was the first opportunity that most of us had had to meet this member in person. Don also received written instructions as to the business he is to conduct for the Aruba Section.

Alternate Delegates, whom the president indicated would assist Don in St. Louis, were: E. J. Hillstead, K. H. Walker, R. G. McWhorter. Other Delegates may be appointed later, when we hear from some of our off island members.

The first speaker was our fellow member, Donald E. Merritt. Don is in charge of the Instrument and Business Machine Repairs for the Shell Caribbean Corporation in Maracaibo, Venezuela. He gave a very interesting description of his activities there and we were surprised to find that due to the "dollar situation" most of his equipment comes from England. His description of difficulties encountered in effecting maintenance of instrument equipment was quite vivid. Particularly when he mentioned that an order for parts might take as long as three years before it was filled.

Our second speaker was E. C. Johnson, our fellow member from Hospital Hill here in Aruba. He is in charge of number 2 laboratory in the Lago Refinery and gave a chemist's eye-view of the water situation here. We were interested to learn that collectively in the refinery and Colonies we use something in the excess of 6,000 barrels of drinking water daily at a cost of approximately 9c per barrel. The cost is a little high since all of this water is shipped to us here from various ports on the Eastern Seaboard of the United States. The talk also touched on four other water systems in use in our area, Sea Water, Brackish Water, Boiler Water, and Evaporated Water.

At our August meeting our speaker will be Mr. Russel Ewing of the Lago Engineering Department who will deliver a talk on "The Oil Recovery System as used in Aruba".

—J. L. LOPEZ, *Corr.*

NEW YORK

The sixty-seventh regular meeting of the New York Section was held on May 23rd in the Auditorium of the Consolidated Edison Co., 4 Irving Place, New York City with about 130 attending. This meeting was sponsored jointly with our section and the Radio Club of America. Our President, E. Ralph Manning, conducted the business meeting at which time we presented our past president, Ralph R. Batcher, with a traveling Alarm clock.

The technical program was handled by Mr. Jerry Minter, President of the Radio Club of America. Professor Ernest Weber of Brooklyn Polytechnic Institute presented a talk on Magnetic Amplifiers. The demonstration equipment, which proved very interesting, was ably arranged by Mr. Smith, assisting Professor Weber.

The speaker pointed out that the basic principle which is the saturable reactor used in magnetic amplifiers, was not new and that patents had been taken out as far back as the late 1800's. It was not until the new magnetic alloys such as GyMu 80, hypernik, 4750, dektanaxm etc., were developed that the application of this principle to magnetic amplifiers became a practical reality. These alloys are characterized by a high initial permeability and high flux saturation.

The basic principle of the magnetic amplifier depends upon the saturation of the above mentioned alloys beyond the knee of the magnetization curve with a direct current. Super imposing alternating current flux on the saturated magnetic circuit by means of a separate winding may have a large or small effect on the magnetic circuit, depending upon the degree of saturation. Thus, if a third auxiliary winding is wound on this magnetic circuit, a form of rectified a-c signal will appear on the out-out winding, depending upon the magnitude of the d-c saturation, and the size of the super imposed a-c signal. Two such independent magnetic circuits would be necessary for the transmission of full wave a-c signals.

Professor Weber described the Buchwald circuit which obtains its saturating current by rectifying the current induced in the saturating winding. Power gains of the order of one million have been realized by employing two such circuits.

The advantage of the new alloys over silicon steel are that for one-hundredth of the power input, three times as much gain could be obtained. The disadvantages are the high cost of such amplifiers since they deliver only one three-hundredth of a watt per dollar as compared with silicon steel.

When our regular meetings resume again on Monday, September 26th, the membership will be asked to change our constitution so we may elect officers in May rather than January. This will enable them to perform their duties during all the regular meetings of one season.

—H. R. KALBFLEISCH, *Corr.*

NIAGARA FRONTIER

The regular meeting was held on May 23rd at the New York State Institute of Applied Arts and Sciences in Buffalo. Following dinner in the Institute dining room, the retiring president, Clarence Boltz, opened the meeting and after various reports from committee chairmen were received, spoke briefly on the progress made by this Section during the two years of its existence. He then turned the meeting over to president-elect Joseph Hildyard, who accepted with a short talk on future plans of the organization. Committee chairmen for the coming year were then appointed.

The guest speaker, Mr. Bruce Bevelheimer of the Colorado Fuel & Iron Corporation, Wickwire Spencer Steel Division, gave an interesting talk on the application of instruments to control of open hearth furnaces. Mr. Bevelheimer indicated that instruments in this field are practically indispensible, that they contribute heavily not only to quality control but also to efficient yield, and particularly that operating personnel must be familiar with and have full confidence in the instruments which are used.

—W. J. SOMMERS, *Corr.*

SEE ARTICLE ON NEXT PAGE

THE AUTHOR

Mr. Hall after attending Massachusetts Institute of Technology worked for Industrial Instrument Co. (present Foxboro Co.) from 1909-11. From 1911-16 he was connected with American Pneumatic Service Co. — The Lan-

M. B. HALL

son Co. From 1916 to the present he has been with The Foxboro Co., Foxboro, Massachusetts, successively as Sales Engineering Manager, Automatic Control Div., Manager, Pulp and Paper Div., Supervisor, Technical Publications and Director of Training.

The Development of Instrument Curricula*

By MALCOLM B. HALL

THIS PAPER is being presented with the knowledge that the subject may be controversial, however, ideas that may be too controversial have been avoided and a program is presented that has proved basically sound and workable with practical suggestions for further development.

First, let us establish the premise that industrial instruments are tools but as tools can be either expendable or a capital investment, it is essential that they be classified. Presumably you will accept the statement that industrial instruments are a capital investment and as such they must receive that care and consideration that will enable them to produce the maximum return on the investment.

The theory behind the tool must be understood by those who design it. The functions and limitations must be understood by those who adapt it to their use and the mechanics of the tool must be understood by those whose duty it is to maintain it at its highest operating efficiency. The more complex tool requires a broader knowledge in each of the foregoing categories. This should indicate that there are three levels of knowledge and if this is accepted then it can be concluded that there are three levels of educational training.

The personnel involved at these various levels, for any particular type of tool, increases as the technical level decreases. Relatively few are involved in the design and development of a new tool by any one manufacturer, but in the distribution of that tool to industry as users, many more are involved in an intelligent understanding of the functions and limitations of the tool. In any one industry the personnel involved at this level may be relatively few, whereas at the maintenance level there may be considerably more. There is no intention to imply that there should be a higher order of technical knowledge at the first level than at the second, but it should be obvious that the higher order of technical knowledge should be at the first level; that is, in the theory and design of the tool. It is a mistake to conclude that education at any one of these levels is more important than any other because they are so closely integrated. Although the tool may be designed correctly and adapted correctly it cannot maintain its maximum operating efficiency unless it is maintained correctly. It wouldn't be erroneous to conclude, therefore, that education at the maintenance level is equally important.

At this level we find very few men who have had a formal education beyond high school. They are invariably natural mechanics and have an aptitude for working on more or less intricate mechanisms and industrial instruments offer a broad field for these aptitudes. The training of these men as instrument mechanics has offered a serious problem to industry but it has been met by some of the larger instrument users by establishing within-plant training programs.

Among the information that I have gathered relative to these courses is a booklet of 25 typewritten pages entitled "Qualifications for Instrument Men" by one of the larger chemical companies. This company classifies its instrument maintenance men as — Instrument Helper, Senior Instrument Helper 1 (H1), Senior Instrument Helper 2 (H2), Senior Instrument Helper 3 (H3), Journeymen Instrument Men (J), Instrument Calibrationists and Instrument Technicians. Qualifications for each of these classifications are specified in detail, together with a course of study for each grade to qualify for the next higher grade. Quoting from this information the qualifications for an instrument helper — (1) Must be a high school graduate or have equivalent education. (2) Must have congenial personality and natural ability for instrument work. (3) Must be in good physical condition. (4) Must pass an aptitude test with a grade of 75% or better.

The first 12 months of employment, an Instrument Helper may be assigned work in the instrument parts division, pressure gauge repair, general shop repair, or as helper to Journeyman Instrument Man or Instrument Technicians, or as directed.

During the second 6 months of the above period of employment, an Instrument Helper will be given a review course of 2 hours per week on company time, covering the following subjects: Fractions and decimals, algebraic equations, powers and roots, ratio and proportion, geometry of the right triangle, trigonometry of the right triangle, physics of heat, temperature, pressure, hydraulics, Ohm's law, series and parallel resistance.

During this review course the Instrument Helper will be expected to spend the necessary time at home to complete his assignments. At the completion of this second 6 months' period an Instrument Helper will be required to pass a written examination on the above review course. Also, the Instrument Helper must have the following qualifications: Must be punctual, a good worker, neat worker, careful worker, must show initiative, must demonstrate his ability to learn, must be responsive to orders, must have mechanical ability, must know the use and care of tools as used in the department, must know the importance of precision as applied to instruments, must understand simple electrical circuits and fundamentals of electricity, must be able to identify, make and weld thermocouples, must be able to work in the instrument shop or as a helper to Journeymen Instrument Men, or Instrument Technicians, or as directed, must be able to change charts and ink recorders, must be able to repair and calibrate pressure gauges, either by comparison to a standard or by a dead weight tester.

The training course for Senior Instrument Helper 1 consists of problems in blueprint reading covering 15 lessons in 5 weeks. Standards of measurements, pressure and vacuum gauges, indicating recording bulb type thermometers, thermoelectric pyrometers, covering 57 lessons in 19 weeks; or a total of 72 lessons in 24 weeks. During this training course Senior Instrument Helper 1 will be expected to spend the necessary time at home to complete his assignment notebook.

In each of the next two successive steps the Senior Instrument Helper 2 and 3 have 72 lessons in 24 weeks covering high temperature pyrometry, flow meters, liquid level measurement, telemetering, automatic control theory, automatic control mechanisms, miscellaneous instruments including gas analysis, pH, conductivity, humidity and specific gravity. As Senior Instrument Helper 3, he must be familiar with National Electrical Code of Fire Underwriters as applied to instrument work, he must be able to use a helper and give him proper instructions for the purpose of training and he must be able to change charts, ink, clean, oil, adjust and make replacement of parts and do other minor maintenance on recorders acting as helper to Journeymen Instrument Men.

The formal education program ends with the Senior Instrument Helper 3.

*Presented at the third Annual Conference of the Instrument Society of America, Sept. 13-17, 1948, Philadelphia, Pa.

Note:—Statements and opinions advanced in papers are to be understood as individual expressions of the authors and not those of the Society.

A complete grading system is detailed for home work problems, periodic quizzes, blueprint reading problems, accuracy of sketching, neatness of work, notebooks and final examination. The advance to Journeyman Instrument Man and Instrument Technician is a matter of time and experience with the qualifications completely detailed. The supervision of the instrument department is under a graduate engineer who has acquired an instrument background the hard way.

The job coverage for each classification is indicated in the following table:

(Maintenance Repairs)

	Installation	Put in Operation	Routine	Trouble	Mechanical	Electrical	Calibration	Theory of Opr.
TEMPERATURE								
Expansion Bulb								
Indicating	H1	H1	H1	H1	H1		H1	H1
Recording	H1	H1	H1	H1	H1		H1	H1
Controlling (Simple)	H2	H2	H2	H2	H2	H2	H1	H2
Controlling (Compound)	J	J	H3	J	H3		H1	J
Resistance								
Indicating	H3	H3	H2	J	J	J	J	H2
Recording	H3	H3	H2	J	J	J	J	H2
Controlling	J	J	H3	J	J	J	J	H3
Potentiometer PYR								
Indicating	H3	H3	H2	J	J	J	J	H2
Recording	H3	H3	H2	J	J	J	J	H2
Controlling	J	J	H3	J	J	J	J	H3
Millivolt Meter PYR								
Indicating	H2	H2	H3	J	J	J	J	H2
Recording	H2	H2	H3	J	J	J	J	H2
Controlling	J	J	H3	J	J	J	J	H3
Radiation & Optical PYR								
Indicating	J	J	H3	J	J	J	J	H2
Recording	J	J	H3	J	J	J	J	H2
Controlling	J	J	J	J	J	J	J	H3
Pressure								
Indicating	H	H	H	H	H		H	H
Recording	H1	H1	H1	H2	H		H	H1
Controlling (Simple)	H3	H3	H3	H3	H		H	H1
Controlling (Compound)	J	J	H3	J	J		H3	H3
Flow								
Indicating (orifice)	H3	H3	H3	J	H3		H3	H2
(Rotameter)	H2	H2		H3	H		H3	H2
Recording	J	J	H3	J	J		H3	H2
Controlling	J	J	J	J	J	J	H3	H3
Electric Meters								
Watthour Meters	J	J	H3	J	J	J	J	H3
Voltmeters	J	J	H3	J	J	J	J	H3
Ammeters	J	J	H3	J	J	J	J	H3
Wattmeters	J	J	H3	J	J	J	J	H3
Vacuum Tube Circuits	J	J	H3	J	J	J	J	J
Ovens: Gas & Oil Fired	J	J	J	J	J	J		J
Clocks, Watches, Dial Gages					J		J	J
Controlled Valves	H2	H2	H2	H3	H3	H3		H2
Thermocouples	H1	H1	H1	H2	H		J	H1
Specific Gravity								
Indicating	J	J	H3	J	J	J	J	H3
Recording	J	J	H3	J	J	J	J	H3
Controlling	J	J	H3	J	J	J	J	H3
Liquid Level								
Indicating	H1	H1	H2	H3	H3	J	H3	H3
Recording	H1	H1	H2	H3	H3	J	H3	H3
Controlling	J	J	H3	J	J	J	J	H3
Gas Analysis								
Thermo-conductivity	J	J	H3	J	J	J	J	H3
Absorption	J	J	H3	J	J	J	J	H3
Liquid Analysis								
Electrolytic Cond.	J	J	J	J	J	J	J	H3
pH Metallic Electrode								
Indicating	J	J	H3	J	J	J	J	H3
Recording	J	J	H3	J	J	J	J	H3
Controlling	J	J	H3	J	J	J	J	H3
pH Glass Electrode								
Indicating	J	J	H3	J	J	J	J	H3
Recording	J	J	H3	J	J	J	J	H3
Controlling	J	J	H3	J	J	J	J	H3

The course of study for a within-plant training program of this type would be governed largely by the types of instruments used. Obviously, no instruction would be necessary in pH instruments if such were not used in the plant. It is interesting to note, however, that the training program includes elementary mathematics and physics and this is included in the several within-plant training programs that I have had an opportunity to study.

Those companies who have set up such programs have done so from dire necessity because there is very little practical text at the instrument mechanic level.

Many of the leading instrument companies have set up training courses for customers' instrument men and the men taking these courses quite often become the key men in a within-plant training program. The popularity of these courses is a glaring testimonial to the lack of good basic industrial instrument text.

The greatest weakness in industrial instrument education is at the engineer-school undergraduate level. These men who are going out into industry with B.S. degrees in chemical, mechanical or electrical engineering are those who should understand the functions and limitations of the tools with which they are to work. On October 16, 17 and 18 in 1945 there was held at Carnegie Institute of Technology, in Pittsburgh, a conference on Instrumentation and the University. Approximately 200 attended, representing educators, instrument users and instrument manufacturers. There were very excellent papers presented at that conference, together with very interesting discussions, all of which were published in Instruments magazine November 1945. The titles of some of these papers were "Instrumentation for Engineers," "Instrumentation in the Mechanical Engineering Curricula," "Industrial Instruments for Chemical Engineering Students," "A College Course for an Instrument Engineer," "Fitting Instrumentology into the College Curriculum." "Education and Instrumentation for the Process Industry," "Undergraduate Preparation for the Field of Instrumentation," "Status and Training of Instrument Engineers in the Rubber Industry." These are but a few of the 30 papers and I want to quote from one or two of these papers, as well as from the discussions, without reference to the author, title or speaker.

"What sort of training in instrumentation is most needed by engineers? In my opinion what is needed is to add to the present training some basic knowledge about the various classes of instruments and of the theory on which their design is based, thus trying to give them a definite understanding as to the possibilities and limitations of instruments. In other words, the same training that is now being given relative to the other tools of unit processes should be given on instruments." And from the same paper, "Give us, however, chemical and mechanical engineers that are going out as prospective chief engineers or plant managers with enough knowledge about the fundamentals of instrumentation so that we can use our new tool to best advantage."

Quoting from a speaker in discussion, "We need expert chemical engineers, but we also need mechanical and chemical engineers who know what can be done with instruments, not instrument engineers, not men with a Doctor's or Master's Degree in instrument engineering. What we need is a man who knows what instruments can do for him and knows how they should be installed. If a course in instrument application could be put into the curriculum of chemical engineers, I think it would be a great step forward." And another quote from the discussion, "The underlying thought was not for the universities to develop instrument engineers but to include enough of a course in instrumentation so that when the man goes out as a chemical engineer, for example, he would know something about the instruments necessary in that type of work." And, finally, quoting from a paper "Industry's need is for graduate engineers with a practical knowledge of industrial instruments and instrumentation. The chemical engineer finds a field of activity in practically every industry. Mechanical and electrical engineers design and operate industrial equipment. These men should be equipped with a knowledge of instrumentation that will make it possible for them to develop new processes and improve present processes for greater efficiency. They are potential selectors of industrial instruments. They should know the basic principles of the various types of instruments, how they function, where, why and how they are applied. They should understand the theory and practice of instrument calibration. They should have the industrial instruments with which to work and in which to get their hands to acquire the feel and understanding of the mechanism; and the laboratory experimental work should be set up to emphasize the characteristics and limitations of the instruments. These engineers should understand the functional difference between the various types of automatic control mechanisms and why they must be different to cover the broad field of applications."

It is quite evident from the foregoing that it was the consensus of the instrument users at that conference that engineering school graduates should acquire some knowledge of the tools with which they were to work when they went out into industry.

It is very gratifying to note that since the conference, there has been a quite vigorous activity among the engineering schools to establish some kind of program for teaching instrumentation. Very little is known about their courses of study but there are apparently very few schools who have an instrumentation course as a curriculum item. One school is teaching instrumentation in three different departments with apparently no attempt at a standardized course of study.

One of the major problems in establishing instrumentation courses in engineering schools is the education of the teaching staff so that they will have a practical understanding of instruments; a secondary problem is to have the instruments with which to work.

Engineering schools are in the business of selling education just as instrument manufacturers are in the business of selling instruments. The instru-

ment manufacturers are willing to cooperate with educational institutions by providing special discounts for equiment but educational institutions have a capital investment in plant and equipment. They set up hydraulic, mechanical and chemical engineering laboratories and instrumentation should be a part of the set up. Requests have been made for cut-away sections of instruments for class room work. The cut-away section of a simple mercury float type differential recording instrument involves a cost many times greater than the price of an instrument and a cut-away section instrument is a static object whereas a complete operating instrument would be of much more value from a teaching point of view. Instrument manufacturers publications show interior and cut-away views of their equipment.

To quote again from one of the educators at the 1945 conference, "A professor or instructor trying to teach instrumentation has to be a super-specialist to keep up with the developments in the field. If he attends all the meetings, writes for every bulletin that comes out and has excellent industrial contacts, he may obtain enough information to be a real up-to-date instructor for his students." And again, "If a man who is teaching didn't have to rely on 20 or 30 years of experience to accumulate the pertinent information, I believe things would move along a lot faster in the teaching of instrumentation." This might well suggest that the Education Committee of the Instrument Society of America take on the project of establishing a summer course in instrumentation for teachers.

An engineering school in the East has been giving a course in instrumentation for the past 4 years. It is a separate course in the chemical engineering curriculum and is given in the first semester of the senior year and consists of 2-hours' lecture, 3-hours' lab and 4-hours' preparation per week. The Sub-Committee on Industrial Instrument Education of I.S.A. suggested that this school offer a summer course for teachers along the lines of the course that they have established for their chemical engineering students. This school sent an invitation to eighty engineering schools including an outline of the course which was to cover a 3-weeks' period. The fee for the course was set at $35 and board and room arrangements were made at a fraternity house at $25 per week. The minimum enrollment was set at 15 and the maximum 25. Only two applications were received and for lack of interest the course was abandoned.

Following is an outline of the Industrial Instrumentation Course established in this engineering school and offered as a summer course.

OUTLINE OF INDUSTRIAL INSTRUMENTATION COURSE LECTURES

I Pressure

II Differential Pressure
- (a) Fluid Measurement.
  - (1) Differential pressure producers.
  - (2) Differential pressure measures.
- (b) Liquid Level.

III Temperature
- (a) Filled Thermal Systems.
- (b) Thermoelectric Pyrometers.
- (c) Resistance Thermometers.
- (d) Optical Pyrometers.
- (e) Total Radiation Pyrometers.

IV Humidity Measurement
- (a) Wet and Dry Bulb.
- (b) Expansible Membrane.
- (c) Dew Point.

V Automatic Control
- (a) On-Off.
- (b) Proportional.
  - (1) Proportional plus rate floating.
  - (2) Proportional plus rate floating plus derivative.
- (c) Mechanisms.
- (d) Valve Characteristics.
- (e) Miscellaneous Control.

VI Remote Measurement Transmission
- (a) Pneumatic Telemetering.
- (b) Electrical Telemetering.

VII Electronic Measurement
- (a) Demonstration of Instruments.
- (b) Conditions Determining Choice of Electronic Instruments.
- (c) Principles of Operating.
- (d) Types of Measurements.

VIII Applications of Industrial Instruments

LABORATORY WORK

1. Construction and Calibration of Bourdon Gauge.
2. Construction and Calibration of Pressure Recorder.
3. Calibration and Operation of Fluid Flow Recorder.
4. Calibration and Operation of Industrial Density Recorder.
5. Pyrometry.
   - (a) Calibration of Industrial Thermocouple.
   - (b) Mechanics of the Potentiometer.
6. Humidity Measurement and Control.
7. Studies in Temperature Controlling and Recording.
   - (a) Calibration Tests.
   - (b) Response Tests.
   - (c) Effect of Hydrostatic Head.
8. Calibration and Operation of Liquid Level Recorder.
9. The Alignment of an Automatic Temperature Controller.
10. Studies in Practical Automatic Control.
    - (a) Proportional Pressure Controller on Forced Convection Apparatus.
11. Operation of Automatic Temperature Controller on Pilot Plant Heat Exchanger.
    - (a) On-Off Control.
    - (b) Proportional-Reset Control.
    - (c) Proportional-Reset Control with Derivative Action.
    - (d) Optimum Controller Settings.
12. Studies in Pneumatic Telemetering and Valve Characteristics.
13. Studies in Gas Analysis by Means of Electronic Measurements.

No attempt has been made to go into the mathematics of process control. There are practical applications of instrumentation to pilot plant operation but it was believed that anything beyond that should be at the graduate school level. The soundness of this program is substantiated adequately by the chemical engineering graduates who have participated in this course. They have had no trouble in finding positions at a satisfactory starting salary and have had a reasonable understanding of the instrument tools with which they work.

Apparently some of the engineering schools have the impression that they should train instrument men for the instrument industry. The placement of men in the instrument industry is relatively small. For development work the industry wants well trained mechanical and electrical, or electronic engineers and for sales engineering, mechanical and chemical engineers but it isn't necessary that these men have any particular instrument knowledge because they will acquire their training within the industry.

The big field for instrument educational work is with those engineering school graduates who are going into the instrument user industries and it is logical to conclude that the best instrument curriculum is one which covers the fundamentals of construction and design of basic measuring systems and automatic control mechanisms with examples of applications of these instruments to various processes.

In conclusion, it should be within the scope of the Educational Committee of the Instrument Society of America to recommend a course of study including laboratory work for the guidance of engineering schools in instrumentation courses.

It should also be a function of the committee to supervise the preparation of text for use at the vocational school or instrument mechanic's level. This text to be published by the Instrument Society of America and made available at a reasonable price to the instrument user industry.

Organized Instrument Engineering*

By J. JOHNSTON, JR.

Definition of Necessity for Instrument Engineering

It is increasingly apparent to those familiar with instrument equipment, that almost every branch of industry can derive tangible benefit from an intimate knowledge of some type of measurement or control technique. It is the purpose of this paper to demonstrate the economy of providing such knowledge in the form of instrument engineering personnel. This specialized talent, whether it be represented by a full-fledged department, a single individual or only part-time of an individual, can be, and is, a useful addition to almost every type of industrial organization.

There are many examples of worthwhile instrument engineering which have no human-interest aspect to make them good newspaper copy, but they do excite the interest of corporation management. They become the real salesmen of the necessity for sound instrument use, and promote greater interest in the extraction of maximum value from this relatively new "tool." In fact they justify the very existence of such a specific type of knowledge in the employ of potential users of measurement and control equipment.

One such recent example resulted from an engineer's recognition of the heat loss incidental with the use of diluted sulfuric acid in a process. The latter ingredient had been blended to a given concentration in a cooled tank, preheated, and charged to the reaction vessel. By means of properly applied conductivity, liquid level, and flow control, it is possible to control the heat of dilution of the sulfuric acid as it is mixed. By charging the mixture directly to the vessel at the elevated temperature, a fuel oil saving is effected which results in an annual return of $20,000 for the expenditure of $5500 on instrument equipment.

Industrial processes suffer frequently from a lack of measurement and control equipment. There are instances at almost every turn where improved operations or increased safety and efficiency will result from a usable application of measurement or control.

*Presented at the third Annual Conference of the Instrument Society of America, Sept. 13-17, 1948, Philadelphia, Pa.

Note:—Statements and opinions advanced in papers are to be understood as individual expressions of the authors and not those of the Society.

THE AUTHOR

In 1928 Mr. Johnston was working on inspection and test of measurement and control apparatus. After graduation from Drexel Institute of Technology in 1935, he joined

J. JOHNSTON, JR.

Standard Oil as instrument technician at the Aruba (N.W.I.) Refinery. Later he transferred to Standard's refinery in Campana, Argentina. In 1938 he became instrument service engineer for Sun Oil Co., Marcus Hook, Pa. and later became assistant to the chief instrument engineer. He joined the Design Division of E. I. duPont de Nemours & Co. in 1946 and is now in the Consultants Group, Industrial Engineering Div.

Existing Staff Inadequate

A survey of the types of instrument organization existing in a number of representative industries revealed no consistency with respect to origin or calibre of personnel. In the majority of cases, a formal appointment of instrument staff consisting of previously trained men has never occurred. The necessity for such a staff became felt first in the plants themselves where the periodic service provided by the manufacturer had begun to fall short of plant requirements. It therefore followed that some "handy" individual like the one in Perry's Handbook[1] was picked out and given the assignment of caring for these very temperamental gadgets. Shortly thereafter he became swamped with the necessity for all manner of measurement and control requirements, most of which were to be obtained at zero cost. Surprisingly enough, many of these requests were satisfactorily filled by means of a couple of pounds of scrap parts and about ten pounds of ingenuity.

This was the beginning of what in nearly all cases became the instrument engineering department as it now exists. Out of the first few individuals charged with instrument service responsibility, the man who applied himself to the mastery of the job received early recognition as the expert. On his shoulders rested the entire responsibility for all decisions relating to process measurement and control.

He was working under maintenance supervision in most cases because his first work required that he repair or replace worn parts, keep things oiled, painted, cleaned, and checked, and make use of electrical or machine shop equipment to that end. In many cases he is still reporting to maintenance management and as a result there are many instances where his outgrowth or offspring, the "instrument engineer", is a part of maintenance or mechanical engineering management.

Although this is the accepted and acknowledged line organization found in several large oil refineries and chemical corporations, it is not appropriate to the most efficient use of instrument manpower. This opinion has been expressed by many writers on the subject. Comstock,[2] Kerley[3] and Frost[4] have all held a brief for the benefits derived from removal of the instrument organization from the jurisdiction of unrelated management.

Observations made by the author point up very strongly the advisability of having the whole instrument set-up fall under single line supervision, related as closely as possible to the production or operating department. The most important advantage to the company is the increase in productivity of instrument men resulting from their alliance with people who emphasize product output. To my mind, an automatic controller is an operator and the man responsible for such an item is a part of the operation. You cannot expect to create and maintain enthusiasm for his work in an employee unless you give him an incentive, a reason for his being there, a feeling that he and his services are important to plant production.

Similarly, the information required by instrument engineering has no important relation to any one except the process design engineer in the chemical oil or food industry. In the paper, steel, glass or other similar industry, a close tie-in with machine design engineers would perhaps be desirable. Wherever possible the instrument engineering department should report directly to the individual in charge of process or machine design as a whole. It is then automatically maintained up to date on all design changes and has intimate contact with the persons with whom most of the design time is spent. It can correlate its efforts with identical degrees

of emphasis throughout the progress of the job. During construction and start-up, it is in a position to collaborate with the operating departments in their effort to prepare for final operation.

Qualifications Desired in an Instrument Engineer

The greatest asset in the make-up of the instrument engineer is his knowledge of measurement and control principles, and his familiarity with the equipment and its applicability. Attainment of such an asset can be reached today, far more readily than at any previous time. Formal programs for the training and selection of instrument personnel have been instituted by many instrument users. It is now possible to obtain a technical staff which has absorbed a formal education purposely designed to prepare it for instrument work. This schooling should have been followed by field experience in the manufacture, installation, use and maintenance of instruments in the type of industry concerned. A ten-year background covering these phases should give any prospect all of the preliminary instrument education that he can obtain. His success or failure in engineering duties will depend on his use of common sense, his personality, activity and ambition, and to some extent on the encouragement received from his employer.

A sizeable amount of the work done by an instrument engineering department could very capably be accomplished by the average chemical engineer. His work involves the specification, procurement and installation as an integrated process, a whole variety of machinery and equipment from pipe stills to packing machines. A power plant engineer is equally capable of providing combustion control equipment. He too handles the engineering on a wide variety of water treatment, combustion, fuel preparation, power generation, switchboard, and power distribution equipment.

The instrument field, however, has become so highly competitive, with widely varying ways of doing the same thing, that a great deal of actual experience is required for conclusive evaluation. As an example, steam pressure may be controlled through a reducing valve operated by any of various mediums. It may use the force generated by steam pressure to position the inner valve. It may also use a steam pilot operated device for this purpose or a bourdon-type pressure measurement actuating electrical or pneumatic forces to drive the valve. A pilot may monitor hydraulic forces to piston-actuate the valve or it can use hydraulic pilot means to electrically drive the valve or any of a number of such combinations, each designed to be superior under specific conditions.

The number of possible combinations is tremendous and an attempt to select the one best suited to the particular application should logically become the responsibility of a person interested in such equipment to the exclusion of all others.

The foregoing is typical of the simplest instrumentation ordinarily encountered. The more complicated problems of measurement and control will definitely require the undivided attention of an interested and competent engineer. He would be in a position to save considerable expense to his employer in many ways. One illustration within the author's acquaintance involves the provision of a complete control panel by a single vendor on a special application which had been purchased repetitively on several previous occasions. Shortly after the assignment of an instrument engineer to this particular department, a bid was received for another such control system. The job was quoted on the basis of customer specification and design. The instrument engineer broke it down into several components, obtained quotations by phone on each of these, including one for assembly, and came out with a cost which was $8,000 below that of the privileged vendor. This was possible only because the instrument engineer had the time, the interest and the specific ability to substitute dependable alternatives for the overly elaborate items in the vendor's proposal.

He has also been forced to make his own decisions concerning many special corrosion problems. The company's metallurgical experts can readily recommend an alloy material like duriron for pumps, vessels, piping, fittings, etc., but their investigations are limited to process equipment. Thus they cannot quickly give a firm recommendation to the instrument engineer who must find a resistant material which can be drawn, heat treated, welded and fabricated to a complicated and thin-walled mechanism like a bourdon spiral, torque tube, sealing bellows, ball float, or some equally impossible shape. He checks with the manufacturers regarding their experience in other industries on the possibility of a substitute metal or a sheathing or coating material. Perhaps he has to use an instrument based on a different principle or to change the process to avoid the use of instrument equipment in the corrosive service. As a last resort he may be forced to purge or seal the delicate parts of his instrument with an inert medium available on the plant and not injurious to the process. Ability to recognize such problems in the early stages of design and to propose adequate solutions will only be possible if familiarity with operating conditions and plant practices is consistently maintained. Necessarily, if plants are to be designed and equipment purchased through central engineering in the home office, it should follow that instrument engineering can best be accomplished in the same way.

A satisfactory job can only result, however, from close cooperation with the field forces and positive recognition of field conditions. The instrument man is one type of engineer who quickly loses his value if he is not permitted field contact or is not allowed to follow every job through until all items are performing to the satisfaction of everyone concerned. In a field which is so rapidly changing, the man who is permitted to get out of touch with conditions in the plant and the performance of new equipment will be left so far behind that he may never again catch up. This work is so completely diversified that no individual can hope to be self-sufficient. He may do amazingly well if his interest is completely captured and there is an incentive to his pursuit of knowledge with almost fanatical enthusiasm. The instrument engineer has a responsibility out of proportion to the importance attached to his job. Many processes cannot operate without adequate and dependable automatic control applied correctly, as their success or failure depend to a large degree on the accuracy and sensitivity of properly located measuring devices.

A recent experience indicates the desirability of having competent instrument personnel available for the initial operation of all new process units. This illustration concerns the loss in production of a unit for three weeks plus the expenditure of $5000 in making unnecessary design changes because of a series of erroneous temperature readings caused by insufficient immersion of the measuring element in the thermowell. Such circumstances may or may not occur in the presence of a capable instrument engineer, but when they do they most certainly reflect on his capabilities. Time saved during the initial operation of a continuous process is of inestimable value, and if any such saving results from the effort of an instrument engineer, then we can truly say that his existence is justified.

Ideal Organization

It has been said that a major factor contributing to the success of one of the large manufacturers in the chemical field has been its attitude toward executives. In this company, a top ranking executive is completely freed from routine duties. He makes no periodic written reports to his management, is not fettered with the necessity for applying signatures to routine correspondence, approval of drawings, etc. His whole attention may be focused on the efficiency of operation of his department, on evaluation of results obtained from their output, on maintenance of a proper perspective of the picture as a whole. He is given time to quietly think through each problem to reach a sound, final decision. This is the type of individual under whom it is desirable that an instrument engineering department be placed. He should have a keen appreciation of the many ramifications of this specialized field and be aware of the pitfalls of inadequate instrument engineering. He should be in a position to direct attention to whatever project commands highest priority, and be empowered to adjust manpower to suit variations in work load.

The instrument engineering department should have a basic strength suited to the average construction program. It would be built around an outstanding instrument authority having executive ability. He should be provided with trained stenographic and clerical assistance, selected drafting personnel, competent instrument engineering assistance, plenty of space, an ample library, a library service where he will receive abstracts of pertinent literature, an index of such abstracts, access to an instrument test laboratory where equipment may be evaluated at his direction, or special adaptations of standard equipment made. He should have jurisdiction over the activity of a special research laboratory devoted to the development of equipment not available from manufacturers and which is only necessitated by the requirements of his employer's particular industry, especially those offering possibilities for process improvement over outside competition.

Attack on a Typical Problem

Presumably now we have an instrument engineering department with everything in its favor. To test its abil-

ity we can pull it into a job which is in the embryonic stage. The members assigned will visit the research laboratory where the process is described, examples of the raw materials and of those produced are examined and described. The materials of construction necessary are noted and other pertinent things affecting equipment are observed. They then visit the semi-works or pilot plant operation, discuss measurement and control problems with operating people and learn of the critical phases of the process; those points where accurate measurements are necessary, or exacting conditions of level or pressure, etc., maintained. These data are confirmed with the process engineer and the preliminary layout of the scaled-up unit examined. On the basis of information obtained during these conferences and of the instrument engineers' conception of the process, a preliminary diagram is prepared by him on which is shown all major equipment, its relative location, and a tentative instrumentation. This he uses in a discussion of the job with plant personnel, process and project engineers, his own staff, and so forth. If he is to earn his salt he will have shown instances where instruments can be used to supplant surge capacity, increase continuity, reduce manpower requirements, etc.

He is now required to supply an estimate of instrument cost with a written discussion of the project and its problems. Therein he will also include the cost of alternative designs where a slightly different function or arrangement might permit the use of time cycle or sequence controls, centralized control of operation, and some pertinent observations regarding labor analysis. He discusses measures for increased safety and fire protection and facilities for future expansion, he reports the general type of control involved at each phase of operation, itemizes the equipment required, giving general specifications, flow rates, pressure drops, temperatures, materials specifications, valve sizes, and so forth. He affixes an approximate price for each item and obtains firm data and prices on non-standard items. This establishes all information on the job on a sufficiently firm basis for inclusion in a formal estimate.

If authorization for construction is obtained, the basic data is rechecked and made firm, orders are placed for the instrument and accessory equipment, information is obtained from the selected vendor and included on the drawings. The drafting work proceeds under the direction of the instrument engineer and must, of course, be effected by men having familiarity with instruments standards, installation practices, instrument equipment uses, electrical signal practices, wiring diagrams and panel layout.

Procurement of instrument equipment requires the preparation of detailed specification far exceeding that indicated by the dollar value of the total purchases. Each instrument will cost an average of only $250, and will require about one-half page of specification. The expenditure of $50,000 then entails preparation of around 100 pages of detailed specification. Compared with the project engineer, who may specify that amount of equipment on a single page, the instrument engineer has the more laborious task.

The design is now complete except for the transmittal of information to the field. The function of each instrument, its relation to the process and to other instruments must now be fully described and identified with vendor's name, order number, drawing references and all special operating instructions or installation details. Calibration charts, orifice calculations and control valve sizes must be correlated in preparation for field installation. A running record of project status must be reported to all divisions whose work must dovetail with that of instrumentation.

A visit to the construction site should be made as soon as construction forces are organized, to advise the construction instrument engineer of the magnitude of the project, the extent of storage facilities required, the expected delivery on each type of equipment, the types and numbers of accessories necessary, and to confer on particular instruments where installation methods are of a special nature.

This must be followed by trips to the field for conferences with operating groups, participation in an operator training program, and provision of the instrument service men with information to assist them in predicting manpower requirements, spare parts additions, special training needs and to generally assist them in becoming familiar with what is eventually going to be their "baby."

There are always numerous decisions to be made in the field which are brought about by unforeseen conditions or incomplete design. These require the frequent presence of the instrument engineer as referee during the period of instrument installation.

When start-up day, or night rather, arrives, he will, of course, place himself at the disposal of the operating forces. Here is where he learns something about the difference between theory and practice. He sees that some of his engineering has paid dividends commensurate with the thought given it. He finds that those elements appraised as most difficult and therefore receiving great attention have now proved simple and offer no problem, whereas those which seemed trivial and looked easy now become major bottlenecks. He has, however, profited greatly by the experience and has increased his value to himself and to his employer. Each succeeding project will benefit from his previous experience and this educational procedure should continue unceasingly.

At the completion of the project, his effort will represent less than 1% of the total engineering design cost of the job. He will have influenced the procurement of less than 10% of the dollar value of all equipment purchased, and will have had contact with every single phase of the process design and construction.

Evaluation of Results

Although our subject has been restricted to the design phase of the process, we should not overlook other tangible returns from an investment in instrument manpower. Not the least of these is that realized from a reduction in the complication associated with subsequent alterations, additions or deletions. Proper installation practice is responsible also for ease of maintenance of instrument items and in fact for the elimination of much of the necessity for excessive maintenance. Additional revenue may also result from the participation of instrument people in the research and experimental program, and from the discovery of means for increasing the efficiency of existing plant practices.

The ever-increasing complexity of process control methods is focusing attention more sharply on the shortcomings of existing equipment. Elimination of obstacles to the use of modern developments is only possible through the concerted effort of manufacturer and customer. The manufacturer is well represented in capable engineering strength, but he does not have access to the customer's plant or process to a sufficient degree for competent analysis of the need. Progress can therefore most rapidly be made by action on the part of the instrument user through his assignment of specially trained personnel to the search for measurement and control application.

Our present discussion has been concerned with the performance of one such force in the design and construction phase of a typical project. There have been examples of the benefits to be expected from such talent, and many reasons have been cited in favor of its existence. The most important argument for organized instrument engineering is the fact that it can pay its own way, and we hope this paper has in some measure illustrated the reality of that fact.

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Correction Notice

On Page 120 of

The 1950 Instruments Index

Cash Valve Mfg. Co., A. W., Wabash and Morgan, Decatur 99, Ill.

should read

Cash Co., A. W. Decatur, Ill.

Manufacturers of Automatic Combustion Control Systems

SECTION SECRETARIES AND MEETING DATA

	Telephone	Date	Dinner	Mtg.
Akron: Fred Appel, 932 Columbia Ct., Barberton, Ohio.		4 Tues.	X	8
Aruba: A. S. MacNutt, c/o Lago Oil & Transport Co., Ltd., Aruba, N.W.I.		1 Tues.	X	7
Atlanta: H. Kockritz, Fischer & Potter Co., 84 Peachtree St., Atlanta, Ga.		4 Mon.	X	7
Baltimore: Felix Cox, Bethlehem Steel Co., Sparrows Point, Md.		2 Fri.		
Baton Rouge: James H. Simpson, 3647 Gladiola, Baton Rouge, La.				
Boston: C. J. Nazzaro, 456 Central Avenue, Milton 87, Mass.		Last Wed.	6:00	7
California: D. D. Taylor, 234 E. Colorado, Pasadena 1, Calif.		1 Tues.	6:30	
Central Illinois: H. F. Lange, 2101 W. Glen Avenue, Peoria 5, Ill.		1 Wed.	6:30	7
Central Indiana: H. F. Coffey, 110 G Nelson Ave., Tyndall Towne, Indianapolis, Ind.		1 Tues.	X	7
Charleston: Albert H. Hix, 1529 B Dixie St., Charleston 1, W. Va.		1 Mon.	X	8
Chicago: Floyd E. Ertsman, Rm. 1420 Fisher Bldg., 343 S. Dearborn St., Chicago, Ill.		1 Mon.	6:30	8
Cincinnati: Edward H. Muhleisen, 320 Durrell Ave., Cincinnati 15, Ohio		3 Fri.	X	8
Cleveland: R. M. Woodside, Brown Instrument Div. of Minneapolis-Honeywell Reg. Co., 5005 Euclid Ave., Cleveland 5, Ohio.		4 Wed.	6:30	8
Cumberland: Clyde Babst, P.O. Box 447, Cumberland, Md.		Tues. after 4 Mon	6:30	8
Detroit: Seymour Sterling, 13331 Linwood, Detroit, Mich.		3 Tues.		
Eastern New York: Wm. J. Claffie, Winthrop-Stearns, Inc., 33 Riverside Ave., Rensselaer, N. Y.		1 Tues.	6:30	8
Gulf Coast: A. E. Bunn, 2237 North St., Beaumont, Texas.		3 Tues.		
Houston: E. E. Kleir, 2518 S. Blvd., Houston 6, Texas.		Last Mon.	X	8
Inyokern, China Lake, Calif.: A. G. DeBell, U. S. Naval Ordnance, Test Sta., China Lake, Calif.				
Kansas City: Lewell F. Spies, J. F. Pritchard & Co., 908 Grand Ave., Kansas City, Mo.		Last Tues.	6:30	7:30
Louisville: H. C. Schermus, 980 Palarka Rd., Louisville, Ky.		4 Tues.	X	8
Montreal: L. J. Mizuhara, Monsanto (Canada) Ltd., 425 St. Patrick St., Ville LaSalle, Quebec, Canada.		Last Mon.	X	8
New Jersey: W. D. Archibald, 605 Westminster Ave., Elizabeth 3, N. J.		1 Tues.	6:00	
New Orleans: W. H. Haney, 2927 Music Avenue, New Orleans, La.		*No Regular Date*		8
New York: Norman J. Cherry, Merrick, L. I., N. Y.		Last Mon.	6:30	8
Niagara Frontier: Mrs. James L. Martin, 697 Potomac Ave., Buffalo 9, N. Y.	GR. 1450	4 Mon.	6:15	8
North Texas: F. Zapffe, Lone Star Gas Co., 2701 Logan St., Dallas 1, Texas.				
Northern Indiana: J. Baum Beckman, 547 N. Waller Ave., Chicago 44, Ill.		3 Wed.	6:30	7:30
Oak Ridge: John H. Clark, 138 Clayton Hall, Oakridge, Tenn.		1 Wed.	6:30	7:30
Ontario: John W. Huether, 311 Southerland Dr., Leaside, Ontario, Canada.		3 Thurs.	6:45	
Philadelphia: C. W. Wood, 6908 Market St., Upper Darby, Pa.		3 Wed.	X	8
Pittsburgh: Miss Louise Suckfield, c/o P.O. Box 2038, Pittsburgh 30, Pa.		4 Mon.	6:30	8
Presque Isle: Edwin P. Schuwerk, 445½ Halley St., L. P., Erie Pa.		4 Tues.	X	8
Richland: R. S. Hammond, 402 Abbott, Richland, Washington.		2 Wed.	X	7:30
Rochester: R. C. Swartz, Jr., 1201 Granite Bldg., Rochester 4, New York.		4 Tues.	X	8
St. Louis: W. G. Lee, 4710 Delor St., St. Louis 16, Md.		1 Wed.	X	8
Sarnia: Mr. Fred T. Yarke, 140 St. Clair St., Point Edward, Ontario, Canada.		2 Fri.	X	
South Bend: Sam M. Rouse, 436 Moccasin Ave., Buchanan, Mich.		1 Thur.	6:30	7:30
South Michigan: Homer Kuiper, 2517 Hillsdale, Kalamazoo, Mich.		2 Wed.	6:30	8
South Texas: H. C. Givens, La Gloria Corp., P.O. 637, Farfurrias, Texas.		1 Tues.	X	7:30
Tennessee: N. M. Taylor, 16 Edgewood, Kingsport, Tenn.		*No Definite Night*	7:00	8
Tulsa: C. R. Horton, 8211 E. 7th, Tulsa, Oklahoma.		1 Mon.	X	7:30
Twin Cities: Ray Hooper, International Div. Minneapolis-Honeywell Reg. Co., 2753 Fourth Ave., Minneapolis 8, Minn.		4 Tues.	6:30	
Washington: Edwin G. Brown, c/o American Instrument Co., 8010-20 Georgia Avenue, Silver Springs, Md.		3 Mon.	X	7:30
Wayne County: Robert Karr, 2455 Biddle Avenue, Wyandotte, Michigan.		3 Mon.	6:30	8

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INSTRUMENTATION ENGINEERS (six wanted). To aid in the selection, development, installation and operation of direct inking electronic recording instruments of a type similar to those used in the chemical process industries. Work involves measuring and recording of pressures, temperatures, flows and other physical quantities. Applicant should have a B.S. in E.E. or Physics and should have at least two years experience in instrumentation and measurement engineering as well as a sound background in electronics. Location: Southern California. Write for application blank. Box 239.

• • •

INSTRUMENT MECHANICS (twelve wanted). To install, operate and maintain industrial type electronic direct inking recording instruments and photographic oscillographs, for measuring and recording pressures, temperatures, flows and other physical quantities. Ability to modify commercial apparatus under limited engineering supervision is desirable. Applicant should have at least two years experience in instrument work and should have a working knowledge of electronics. Graduation from service Radar and/or instrument training couses is helpful but not necessary. Location Southern California. Write for application blank. Box 240.

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Manufacturers' New Literature

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R-392 CAPACITORS. 30-page Catalog 400 aids in selection of capacitors made in accordance with JAN-C-25. Essential identification, description, and specifications are given. Index and cross index are included.—Cornell-Dubilier Electric Corp., South Plainfield, N. J.

R-393 "SCIENTIFIC APPARATUS AND METHODS." 68-page spring 1949 issue of this house organ contains two sections: Section one presents articles titled: "Theory and Maintenance of the Manometric Blood Gas Apparatus," "Radiant Heating of Organic Combustion Apparatus." Section two contains descriptions and illustrations of new items, reinstated items, discontinued items, changes in specifications.—E. H. Sargent & Co., 155-165 East Superior St., Chicago 11, Ill.

R-394 pH EQUIPMENT. 2-page Bulletin No. 128 describes and pictures maker's pH equipment. Advantages of carefully maintained pH balance applied to materials and process, etc. are discussed.—Macbeth Corp., 227 W. 17th St., New York 11, N. Y.

R395 ELECTRONIC ANALOG COMPUTORS. 2-page bulletin describes and illustrates maker's electronic analog computors for high-speed synthesis and analysis of dynamical systems. Fields of technology served directly by maker's analog computors, methods of solving user's problems are listed.—G. A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass.

R-396 ANALOG COMPUTOR COMPONENTS. 4-page bulletin describes and illustrates maker's individual components; self contained operational units engineered to perform special functions as part of a computing system.—G. A. Philbrick Researches, Inc., 230 Congress St., Boston 10, Mass.

R-397 AUTOMATIC METERING SYSTEM. 8-page Bulletin FL-49 describes and illustrates maker's "Fluidometer" automatic metering system for batching light or heavy liquids. Features included are: resets automatically, eliminates human element, extreme accuracy, etc. Applications, adaptations to measuring problems, etc. are discussed.—Hetherington & Berner, Inc., 701-745 Kentucky Ave., Indianapolis 7, Ind.

R-398 POCKET MICROSCOPE. 4-page booklet describes and illustrates maker's "Ederscope" pocket microscope which has more than 25 power magnification; precision ground lenses; fits pocket like a pencil.—Eder Instrument Co., 1849 N. Halsted St., Chicago 14, Ill.

R-399 "COOK RELAY NEWS LETTER." 2-page No. 1, Vol. 3 issue of this weekly newsletter describes and illustrates maker's electric differential relay, a two-way relay with balance of armature control, double action, interlock control unit. Uses and applications are discussed.—Cook Electric Co., 2700 North Southport Ave., Chicago 14, Ill.

R-400 "INSTRUMENT NOTES." 4-page No. 8 issue of this house organ presents article titled: "A Note On Electrical Resistivity."—Statham Laboratories, Inc., 9328 Santa Monica Blvd., Beverly Hills, Calif.

R-401 "THE CAPACITOR." 16-page Vol. 14, No. 5 issue of this house organ presents article titled: "Inductive and Reactive Effects of Lead At Ultra-High Frequencies." Contains section titled: "Radio Trading Post," a free market-place for buyers, sellers, and swappers.—Cornell-Dubilier Electric Corp., Hamilton Blvd., South Plainfield, N. J.

R-402 TELEVISION TUBE COMPLEMENT CHART. 6-page folder is a television tube complement chart for reference by radio and television servicemen. Lists total tube complement, viewing tube type, and number of tubes by type in 110 television receiver models produced by 44 manufacturers.—Advertising Dep't, Sylvania Electric Products, Inc., Emporium, Penna.

R-403 MICROMETERS. 8-page catalog describes and illustrates maker's micrometers, listing sizes, ranges, etc. Includes depth thermometers, inside micrometers, internal indicator gages, micrometer stands, etc.—Swedish Gage Co. of America, 8900 Alpine Ave., Detroit 4, Mich.

R-404 MOLECULAR MODELS. 2-page bulletin describes and illustrates maker's molecular model sets to aid organic chemistry students in visualizing three dimensional structure; concept of molecular structure, etc.—E. H. Sargent & Co., 155-165 East Superior St., Chicago 11, Ill.

R-405 ASSEMBLY SUPPORT SYSTEM. 6-page folder pictures and describes new system for supporting laboratory bench assemblies, supplementing the ringstand and special purpose stands. Features: stress, stability, rigidity, etc. are discussed.—E. H. Sargent & Co., 155-165 E. Superior St., Chicago 11, Ill.

R-406 REDUCING VALVES. 6-page folder describes and illustrates maker's reducing valve, a positive dead end valve which will reduce from 500 lbs. to ounces in one step. Sizes, prices, etc. are discussed.—C. E. Squires Co., 18502 Syracuse Ave., Cleveland 10, Ohio.

R-407 ROTAMETERS. 8-page bulletin describes and illustrates maker's "Full View" rotameters with safety shielding. Standard modifications of rotameters are pictured and discussed.—Brooks Rotameter Co., Lansdale, Penna.

R-408 COMBUSTION CONTROLLERS. 16-page Bulletin No. C-22 describes and illustrates maker's equipment for combustion control for stationary or marine, coal, oil, or gas firing. Described are: steam pressure regulators, electric power units, etc.—Ace Instrument Co., Inc., 172 Pacific St., Brooklyn 2, N. Y.

R-409 TEMPERATURE INDICATOR AND RECORDER. 4-page bulletin describes and illustrates maker's "Multi-bank Speedomax" which checks temperatures of up to 160 points of location from one convenient place.—Leeds & Northrup Co., 4911 Stenton Ave., Philadelphia 44, Penna.

R-410 STEAM-AIR OR GAS METER. 16-page Bulletin 400-F1 describes and illustrates maker's "Model SMKS" "Shuntflo" meter for measurement of steam, air, or gas flow in lines from one to twelve in. diameter. Operation, installation, capacities, specifications, etc. are discussed.—Builders-Providence, Inc., Div. of Builders Iron Foundry, Providence 1, R. I.

R-411 "GENERAL RADIO EXPERIMENTER." 8-page Vol. 23, No. 12 issue of this house organ presents article titled: "A High-Power, Low-Speed Stroboscope."—General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

R-412 STEAM SPECIALTIES. 4-page folder describes and illustrates maker's steam specialties including: steam and air traps, reducing and regulating valves, boiler feed water controller, regulating valves, etc.—C. E. Squires Co., 18502 Syracuse Ave., Cleveland 10, Ohio.

R-413 **TECHNICAL GLASSWARE.** 16-page brochure describes and illustrates maker's method of glassmaking including: glass blowing, forming precision bore tubing, engraving, etc. Items made to customers' specifications are shown, and suggestions for design of special apparatus are given.—Kontes Glass Co., Vineland, N. J.

R-414 **"WHEELCO COMMENTS."** 4-page Vol. 8, No. 3 issue of this house organ presents discussions titled: "World's Smallest Continuous Furnace Features Wheelco Controls," "Baldwin Locomotive Company Builds New Turbine Blade Fatigue Tester," and others.—Wheelco Instruments Co., 847 West Harrison St., Chicago 7, Ill.

R-415 **RECORDING VISCOMETER.** 8-page bulletin describes and illustrates maker's recording viscometer for measuring the viscosity of all solutions at atmospheric pressures. Said to be particularly appliable in textile, paper, paint, plastics, varnish, and other such industries.—Norcross Corp., Newton 58, Mass.

R-416 **AIR VALVE CATALOG.** 20-page Catalog section 301 describes and illustrates 21 models which make up entire line of maker's "4-Way Air Valves." Description of each model includes working drawings, specifications, cutaway views, etc.—Gerator May Corp., Baltimore 3, Md.

R-417 **AIR METER.** 4-page Bulletin 25A describes and illustrates maker's "Anemotherm" air meter for direct, instantaneous readings of air velocity, air temperature, static pressure. Construction, operating principles, etc., are discussed.—Anemostat Corp. of America, 10 East 39th Street, New York 16, N. Y.

R-418 **"INSTRUMENT NEWS."** 4-page Vol. 5, No. 2 issue of this house organ presents discussion of "Frahm" resonant reed instruments; contains questions and answers section on insulation testing.—James G. Biddle Co., 1316 Arch Street, Philadelphia 7, Penna.

R-419 **COMBINATION SPECTROGRAPH SOURCE.** 4-page Bulletin 300 describes the "Spec-power," which combines the three standard spectrographic units (d-c. arc, a-c. arc, and spark) in a single power supply. Controls, features, etc., are discussed.—National Spectrographic Laboratories, Inc., 6300 Euclid Ave., Cleveland 3, Ohio.

R-420 **PROCESS INDUSTRY INSTRUMENTS.** 8-page Bulletin 17 describes and illustrates maker's instruments and controllers for process industries. Process controllers, controller components, typical systems, multi-element systems, etc., are discussed.—Bailey Meter Co., 1050 Ivanhoe Road, Cleveland 10, Ohio.

R-421 **ELECTRONIC INSTRUMENTS.** 12-page Bulletin 231-A describes and illustrates maker's electronic instruments for temperature pressure, flow, and other factors. Features, etc. are listed.—Bailey Meter Co., 1050 Ivanhoe Road, Cleveland 10, Ohio.

R-422 **"FAXFILM FAX."** 2-page Vol. 3, No. 2 issue of this house organ presents discussions of ways to sell products through use of maker's "Faxfilm."—The Faxfilm Co., 1220 West Sixth St., Cleveland 13, Ohio.

R-423 **MULTI-CIRCUIT TIME CONTROLS.** 2-page bulletin describes and illustrates maker's standard No. 80 series, single cycle timer which may be used in a panel arrangement for controlling any number of circuits.—Walser Automatic Timer Corp., Graybar Bldg., New York 17, N. Y.

R-424 **AUDIO AND POWER TRANSFORMERS.** 16-page catalog illustrates and describes complete line of maker's audio and power transformers and reactors. Included are mounting and construction details, dimensional drawings, frequency response curves for many of the audio units, and table of power-VU-db relationships.—Chicago Transformer, Div. of Essex Wire Corp., 3501 W. Addison St., Chicago 18, Ill.

R-425 **HERMETICALLY SEALED TRANSFORMERS.** 4-page folder describes and illustrates maker's line of hermetically sealed transformers bias and filament transformers, and filter reactors all constructed to meet grade 1, class A, JAN-T-27 specifications. Electrical and

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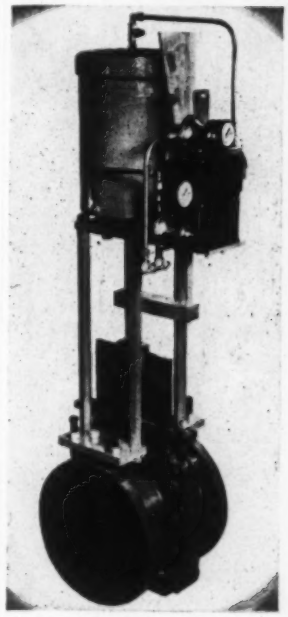

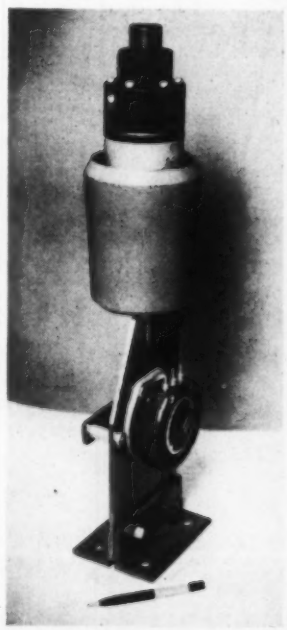

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dimensional data included.—Chicago Transformer, Div. of Essex Wire Corp., 3501 Addison St., Chicago 18, Ill.

R-426 VARIABLE-SPEED DRIVE. 2-page Bulletin 99 describes and illustrates maker's "Type 4A" miniature variable-ratio speed changer small enough to hide in hand; weighing 6 oz. Features, modifications, general specifications, etc. are discussed.—Metron Instrument Co., 432 Lincoln St., Denver 9, Colorado.

R-427 "CENCO NEWS CHATS." 26-page No. 64 issue of this house organ presents discussions of the "American Association of Cereal Chemists," and apparatus for microchemistry. Descriptions of maker's products are given.—Central Scientific Co., 1700 Irving Park Road, Chicago 13, Ill.

R-428 INSULATION TESTING. 24-page Bulletin 21P8-28 titled: "For Practical Men" covers insulation resistance testing in simple language. Simplicity of making insulation resistance measurements with maker's "Megger" is emphasized.—James G. Biddle Co., 1316 Arch St., Philadelphia 7, Penna.

R-429 INDICATING PYROMETER CONTROLLER. 2-page Bulletin MC-1 describes and illustrates maker's "Multi-Switch Capacitrol," indicating pyrometer controller. Includes suggested applications, measuring and indicating features, etc.—Wheelco Instruments Co., 847 W. Harrison St., Chicago 7, Ill.

R-430 "THE LABORATORY." 32-page Vol. 18, No. 5 issue of this house organ presents discussion titled: "Research Chemists Improve Wartime Synthetic Rubber." Descriptions of several products including laboratory ovens, refrigerated baths, magnetic mixers, dehumidifiers, etc. are presented.—Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Penna.

R-431 AUTOMATIC REGULATING VALVES. 70-page bulletin presents information about thirty types of maker's reducing valves, designed to assist prospective user in selecting type and size valve best suited to requirements.—Klipfel Valves, Inc., Div. of Hamilton-Thomas Corp., 1000 Weller Ave., Hamilton, Ohio.

R-432 DESICCANT-BED DRYING. 32-page Catalog D-27 discusses maker's "Kemp Dryers" for desiccant-bed drying of air, gases, and liquids. General operation of dryer, including drying cycle and reactivation, is included. Special models such as "Bottled Gas Dryer," "Dri-Breather," "Lab-Master Dryer," and others are also described. Selection charts for rapid determination of dryer size required for given job are included.—C. M. Kemp Mfg. Co., 405 E. Oliver St., Baltimore 2, Md.

R-433 RIDE RECORDER. 4-page bulletin describes and illustrates maker's "R-S" two-way ride recorder for pre-transportation testing of packing, crating, and merchandise. Nomenclature and specifications, record interpretation, uses, quakities, etc. are discussed.—Impact Register Co., Champaign, Ill.

R-434 EXPANSION JOINT SELECTION. 28-page "Design Guide To Expansion Joint Selection" aids in simplifying selection and application of expansion joints in piping systems. Data, charts, tables, etc. for selection of size,

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To install, operate and maintain industrial type electronic direct inking recording instruments and photographic oscillographs, for measuring and recording pressures, temperatures, flows, and other physical quantities. Ability to modify commercial apparatus under limited engineering supervision is desirable. Experience in measurement and calibration is essential. Applicant should have at least two years experience in instrument work and should have a working knowledge of electronics. Graduation from service Radar and/or instrument training courses is helpful but not necessary. Location: Southern California. Write for application blank. Box 165, Instruments Publishing Co., 921 Ridge Ave., Pittsburgh 12, Pa.

and type expansion joint necessary for requirements are included.—Chicago Metal Hose Corp., Maywood, Ill.

R-435 pH CONTROL. 16-page Bulletin No. 430 describes and illustrates maker's equipment for measurement and control of pH in industrial processing operations. Equipment includes maker's "Dynalog (electronic) Recorder," "Multi-Record Recorder and Indicator," available pH electrodes, etc.—Foxboro Co., Foxboro, Mass.

R-436 RECORDING MILLIAMETERS. 8-page Bulletin No. 549 describes and illustrates maker's "Model AW" recording milliameter, an instrument for recording small electrical quantities which may be produced by, or related to, non-electrical phenomena. Features, characteristics, etc. are discussed.—Esterline-Angus Co., Inc., Box 596, Indianapolis 6, Indiana.

R-437 ULTRASONIC GENERATOR. 2-page bulletin describes and illustrate's maker's "Type CL" ultrasonic generator for medical, biological, and pathological research and application. Principle feature is special convertible "Transducer" for transmitting high-frequency vibrations to skin of patient or to specimen of tissue or other material under treatment.—Ultrasonic Engineering Co., 4 North 8th Ave., Maywood, Ill.

R-438 STEAM AND LIQUID CONTROL EQUIPMENT. 60-page Catalog No. 49 describes and illustrates maker's steam and liquid control equipment. Included are: pressure regulators, pump regulators, temperature regulators, diaphragm regulators, gas valves, relief valves, etc.—O. C. Keckley Co., 400 W. Madison St., Chicago, Ill.

R-439 HIGH-SPEED CHRONOSCOPE. 4-page Bulletin 100 describes and illustrates maker's "Model 100" chronoscope for the measurement of time from 10 microseconds to 1 second. Features, specifications, etc. are discussed.—American Chronoscope Corp., 316 W. First St., Mount Vernon, N. Y.

R-440 RADIATION COUNTER. 2-page bulletin describes and illustrates maker's "Mark 9 Model 3" "RCL Nuclearometer-Scaler" type instrument for counting alpha, beta, or gamma radiations. High voltage supply, amplifier, scaler, etc. are discussed.—Radiation Counter Laboratories, Inc., 1844 West 21st St., Chicago 8, Ill.

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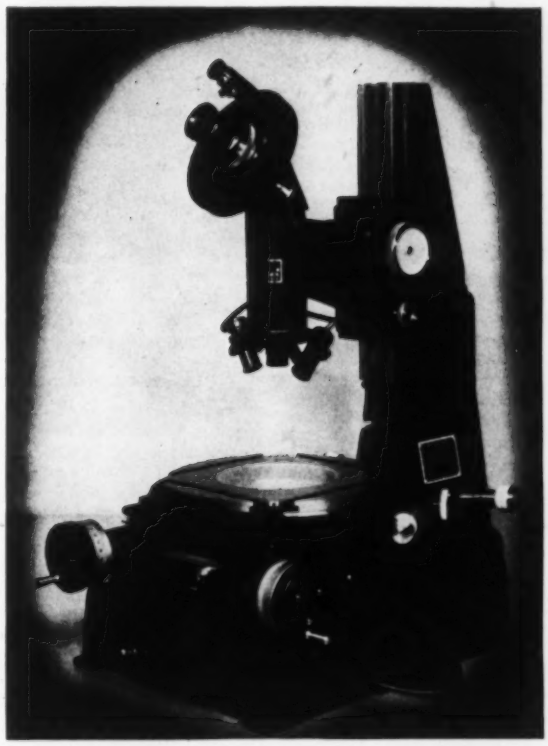

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